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## THE INDUSTRIAL TYPE OF SOCIETY.*

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HAVING nearly always to defend themselves against external enemies, while they have to carry on internally the processes of sustentation, societies, as remarked in the last chapter, habitually present us with mixtures of the structures adapted to these diverse ends. Disentanglement is not easy. According as either structure predominates, it ramifies through the other: instance the fact that, where the militant type is much developed, the worker, ordinarily a slave, is no more a free agent than the soldier; while, where the industrial type is much developed, the soldier, volunteering on specified terms, acquires, in so far, the position of a free worker. In the one case the system of status, proper to the fighting part, pervades the working part; while, in the other, the system of contract, proper to the working part, affects the fighting part. Especially does the organization adapted to war obscure that adapted to industry. While, as we have seen, the militant type, as theoretically constructed, is so far displayed in many societies as to leave no doubt about its essential nature, the industrial type has its traits so hidden by those of the still dominant militant type that its ideal form is nowhere more than very partially exemplified. Saying thus much to exclude expectations which can not be fulfilled, it will be well, before proceeding, also to exclude probable misconceptions.

In the first place, industrialism must not be confounded with industriousness. Though the members of an industrially-organized society are habitually industrious, and are, indeed, when the society is a developed one, obliged to be so, yet it must not be assumed that the industrially-organized society is one in which, of necessity, much work

* Part XI of the series on "The Development of Political Institutions."

is done. Where the society is small, and its habitat so favorable that life may be comfortably maintained with but little exertion, the social relations which characterize the industrial type may coexist with but very moderate productive activities. It is not the diligence of its members which constitutes the society an industrial one in the sense here intended, but the form of coöperation under which their labors, small or great in amount, are carried on. This distinction will be best understood on observing that, conversely, there may be, and often is, great industry in societies framed on the militant type. In ancient Egypt there was an immense laboring population, and a large supply of commodities, numerous in their kinds, produced by it. Still more did ancient Peru exhibit a vast community purely militant in its structure, the members of which worked unceasingly. We are here concerned, then, not with the quantity of labor, but with the arrangements under which it is carried on. A regiment of soldiers can be set to construct earthworks; another to cut down wood; another to bring in water; but they are not thereby reduced for the time being to an industrial society. The united individuals, doing these several things under command, and having no private claims to the products, are, though industriously occupied, not industrially organized. And the same holds throughout the militant society as a whole, in proportion as the regimentation of it approaches completeness.

The industrial type of society, properly so called, must also be distinguished from a type very likely to be confounded with it—the type, namely, in which the component individuals, while exclusively engaged in production and distribution, are under a regulation such as that advocated by socialists and communists. For this, too, involves, in another form, the principle of compulsory coöperation. Directly or indirectly, individuals are to be prevented from severally and independently occupying themselves as they please; are to be prevented from competing with one another in supplying goods for money; are to be prevented from hiring themselves out on such terms as they think fit. There can be no artificial system for regulating labor which does not interfere with the natural system. To such extent as men are debarred from making whatever engagements they like, they are to that extent working under dictation. No matter in what way the controlling agency is constituted, it stands toward those controlled in the same relation as does the controlling agency of a militant society. And how truly the *régime*, which those who declaim against competition would establish, is thus characterized, we see both in the fact that substantially communistic forms of organization existed in early societies which were predominantly warlike, and in the fact that at the present time communistic projects chiefly originate among, and are most favored by, the more warlike societies.

A further preliminary explanation may be needful. The structures proper to the industrial type of society must not be looked for in dis-

tinct forms when they first appear. Contrariwise, we must expect them to begin in vague, unsettled forms. Arising as they do by modification of preëxisting structures, they are necessarily long in losing all trace of these. For example, transition from the state in which the laborer, owned like a beast, is maintained that he may work exclusively for his master's benefit, to the condition in which he is completely detached from master, soil, and locality, and free to work anywhere and for any one, is through gradations. Again, the change from the arrangement proper to militancy, under which subject-persons receive, in addition to maintenance, occasional presents, to the arrangement under which, in place of both, they receive fixed wages, or salaries, or fees, goes on slowly and unobtrusively. Once more it is observable that the process of exchange, originally indefinite, has become definite only where industrialism is considerably developed. Barter did not begin with a distinct intention of giving one thing for another thing equivalent in value, but it began by making a present and receiving a present in return ; and even now in the East there continue traces of this primitive transaction. In Cairo the purchase of articles from a shopkeeper is preceded by his offer of coffee and cigarettes ; and, during the negotiation which ends in the engagement of a *dahabeah*, the dragoman brings gifts and expects to receive them. Add to which that there exists under such conditions none of that definite equivalence which characterizes exchange among ourselves : prices are not fixed, but vary widely with every fresh transaction. So that, throughout our interpretations, we must keep in view the truth that the structures and functions proper to the industrial type distinguish themselves but gradually from those proper to the militant type.

Having thus prepared the way, let us now consider what are, *a priori*, the traits of that social organization which, entirely unfitted for carrying on defense against external enemies, is exclusively fitted for maintaining the life of the society by subserving the lives of its units. As before, in treating of the militant type, so here, in treating of the industrial type, we will consider first the ideal form.

While corporate action is the primary requirement in a society which has to preserve itself in presence of hostile societies, conversely, in the absence of hostile societies, corporate action is no longer the primary requirement.

The continued existence of a society implies, first, that it shall not be destroyed bodily by foreign foes, and implies, second, that it shall not be destroyed in detail by failure of its members to support and propagate themselves. If danger of destruction from the first cause ceases, there remains only danger of destruction from the second cause. Sustentation of the society will now be achieved by the self-sustentation and multiplication of its units. If his own welfare and

the welfare of his offspring are fully achieved by each, the welfare of the society is by implication achieved. Very little corporate activity is now required. Each man may maintain himself by labor, may exchange his products for the products of others, may give aid and receive payment, may enter into this or that combination for carrying on an undertaking, small or great, without the direction of the society as a whole. The remaining end to be achieved by public action is to keep private actions within due bounds; and the amount of public action needed for this becomes small in proportion as private actions become duly self-bounded.

So that, whereas in the militant type the demand for corporate action is intrinsic, such demand for corporate action as continues in the industrial type is mainly extrinsic—is called for by those aggressive traits of human nature which chronic warfare has fostered, and may gradually diminish as, under enduring peaceful life, these decrease.

In a society organized for militant action, the individuality of each member has to be so subordinated in life, liberty, and property, that he is largely, or completely, *owned* by the state; but, in a society industrially organized, no such subordination of the individual is called for. There remain no occasions on which he is required to risk his life while destroying the lives of others; he is not forced to leave his occupation and submit to a commanding officer; and there ceases to be any need that he should surrender for public purposes whatever property may be demanded of him.

Under the industrial *régime*, the citizen's individuality, instead of being sacrificed by the society, has to be defended by the society: the defense of his individuality becomes the society's essential duty. That, after external protection is no longer called for, internal protection must become the cardinal function of the state, and that effectual discharge of this function must be a predominant trait of the industrial type, may be readily shown.

For it is clear that, other things equal, a society in which life, liberty, and property, are secure, and all interests justly regarded, must prosper more than one in which they are not; and consequently, among competing industrial societies, there must be a gradual replacing of those in which personal rights are imperfectly maintained by those in which they are perfectly maintained. So that by survival of the fittest must be produced a social type in which individual claims, considered sacred, are trenched on by the state no further than is requisite to pay the cost of maintaining them, or, rather, of arbitrating among them. For, the aggressiveness of nature fostered by militancy having died out, the corporate function becomes that of deciding between those conflicting claims the equitable adjustment of which is not obvious to the persons concerned.

With the absence of need for that corporate action by which the efforts of the whole society may be utilized for war, there goes the absence of need for a despotic controlling agency.

Not only is such an agency unnecessary, but it can not exist. For, since, as we see, it is an essential requirement of the industrial type that the individuality of each man shall have the fullest play consistent with the like play of other men's individualities, despotic control, showing itself as it must by otherwise restricting men's individualities, is necessarily excluded. Indeed, by his mere presence an autocratic ruler is an aggressor on citizens; actually or potentially exercising power not given by them, he in so far restrains their wills more than they would be restrained by mutual limitation merely.

Such control as is required under the industrial type can be exercised only by an appointed agency for ascertaining and executing the average will; and a representative agency is the one best fitted for doing this.

Unless the activities of all are homogeneous in kind, which they can not be in a developed society with its elaborate division of labor, there arises a need for conciliation of divergent interests; and, to the end of insuring an equitable adjustment, each interest must be enabled duly to express itself. It is, indeed, supposable that the appointed agency should be a single individual. But no such single individual could arbitrate justly among numerous classes variously occupied, and numerous groups variously localized, without hearing evidence; from each there would need to come representatives setting forth its claims. Hence the choice would lie between two systems, under one of which the representatives privately and separately stated their cases to an arbitrator on whose single judgment decisions depended; and under the other of which these representatives stated their cases in one another's presence, while judgments were openly determined by the general *consensus*. Without insisting on the fact that a fair balancing of class-interests is more likely to be effected by this last form of representation than by the first, it is sufficient to remark that this last form is more congruous with the nature of the industrial type, since men's individualities are in the smallest degree trenched upon. Citizens, who, appointing a single ruler for a prescribed time, may have a majority of their wills traversed by his during this time, surrender their individualities in a greater degree than do those who, from their local groups, depute a number of rulers; since these, speaking and acting under public inspection and mutually restrained, habitually express the wills of the majority.

The corporate life of the society being no longer in danger, and the remaining business of government being that of maintaining the conditions requisite for the highest individual life, there comes the question, What are these conditions?

Already they have been implied and comprehended under the administration of justice; but so vaguely is the meaning of this phrase commonly conceived that a more specific statement must be made. Justice, then, as here to be understood, means preservation of the normal connections between acts and results—the obtainment by each of as much benefit as his efforts are equivalent to—no more and no less. Living and working within the restraints imposed by one another's presence, justice requires that individuals shall severally take the consequences of their conduct, neither increased nor decreased. The superior shall have the good of his superiority, and the inferior the evil of his inferiority. A veto is therefore put on all public action which abstracts from some men part of the advantages they have earned and awards to other men advantages they have not earned.

That from the developed industrial type of society there are excluded all forms of communistic distribution, the inevitable trait of which is that they tend to equalize the lives of good and bad, idle and diligent, is readily proved. For, when, the struggle for existence between societies by war having ceased, there remains only the industrial struggle for existence, the final survival and spread must be on the part of those societies which produce the largest number of the best individuals—individuals best adapted for life in the industrial state. Suppose two societies, otherwise equal, in one of which the superior are allowed to retain, for their own benefit and the benefit of their offspring, the entire proceeds of their labor, but in the other of which the superior have taken from them part of these proceeds for the benefit of the inferior and their offspring. Evidently the superior will thrive and multiply more in the first than in the second. A greater number of the best children will be reared in the first, and eventually it will outgrow the second.*

Otherwise regarded, this system, under which the efforts of each bring neither more nor less than their natural returns, is the system of contract.

We have seen that the *régime* of status is in all ways proper to the militant type. It is the concomitant of that graduated subordination by which the combined action of a fighting body is achieved, and which must pervade the fighting society at large to insure its corporate action. Under this *régime*, the relation between labor and produce is traversed by authority. As in the army, the food, clothing, etc., received by each soldier are not direct returns for work done, but

* It must not be inferred that private and voluntary aid to the inferior is negatived, but only public and enforced aid. Whatever effects the sympathies of the better for the worse spontaneously produce, can not, of course, be interfered with, and will, on the whole, be beneficial. For, while, on the average, the better will not ordinarily carry their philanthropic efforts so far as to impede their own multiplication, they will carry them far enough to mitigate the ill-fortunes of the worse without enabling them to multiply.

are arbitrarily apportioned, while duties are arbitrarily enforced, so throughout the rest of the militant society, the superior dictates the labor and assigns such share of the return as he pleases. But as, with declining militancy and growing industrialism, the power and range of authority decrease and uncontrolled action increases, the relation of contract becomes general, and in the fully-developed industrial type it becomes universal.

Under this universal relation of contract when equitably administered, there arises that adjustment of benefit to effort which the arrangements of the industrial society have to achieve. If each as producer, distributor, manager, adviser, teacher, or aider of other kind, obtains from his fellows such payment for his service as its value, determined by the demand, warrants, then there results that correct apportioning of reward to merit which insures the prosperity of the superior.

Again changing the point of view, we see that, whereas public control in the militant type is both positively regulative and negatively regulative, in the industrial type it is negatively regulative only. To the slave, to the soldier, or to other member of a community organized for war, authority says: "Thou shalt do this; thou shalt not do that." But, to the member of the industrial community, authority gives only one of these orders, "Thou shalt not do that."

For people who, carrying on their private transactions by voluntary coöperation, also voluntarily coöperate to form and support a governmental agency, are, by implication, people who authorize it to impose on their respective activities only those restraints which they are all interested in maintaining—the restraints which check aggressions. Omitting criminals (who under the assumed conditions must be, if not a vanishing quantity, still very few), each citizen, while not wishing to invade others' spheres of action, will wish to preserve uninvaded his own sphere of action, and to retain whatever benefits are achieved within it. The very motive which prompts all to unite in upholding a public protector of their individualities will also prompt them to unite in preventing any interference with their individualities beyond that required for this end.

Hence it follows that, while, in the militant type, regimentation in the army is paralleled by centralized administration throughout the society at large, in the industrial type, administration, becoming decentralized, is at the same time narrowed in its range. Nearly all public organizations save that for administering justice, necessarily disappear; since they have the common character that they either aggress on the citizen by dictating his actions, or by taking from him more property than is needful for protecting him, or by both. Those who are forced to send their children to this or that school, those who have, directly or indirectly, to help in supporting a state-priesthood,

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those from whom rates are demanded that parish officers may administer public charity, those who are taxed to provide gratis reading for people who will not save money for library subscriptions, those whose businesses are carried on under regulation by inspectors, those who have to pay the cost of state science and art teaching, state emigration, etc., all have their individualities trenched upon; either by compelling them to do what they would not spontaneously do, or by taking away money which else would have furthered their private ends. Coercive arrangements of such kinds, consistent with the militant type, are inconsistent with the industrial type.

With the relatively narrow range of public organizations, there goes, in the industrial type, a relatively wide range of private organizations; the spheres left vacant by the one being filled by the other.

Several influences conspire to produce this trait. Those motives which, in the absence of that subordination necessitated by war, make citizens unite in asserting their individualities, subject only to mutual limitations, are motives which make them unite in resisting any interference with their freedom to form such private combinations as do not involve aggression. Moreover, beginning with exchanges of goods and services under agreements between individuals, the principle of voluntary coöperation is simply carried out in a larger way by any incorporated body of individuals who contract with one another for jointly pursuing this or that business or function. And yet, again, there is entire congruity between the representative constitutions of such private combinations and that representative constitution of the public combination which we see is proper to the industrial type: the same law of organization pervades the society in general and in detail. So that an inevitable trait of the industrial type is the multiplicity and heterogeneity of associations, religious, commercial, professional, philanthropic, and social, of all sizes.

Two indirectly resulting traits of the industrial type must be added. The first is its relative plasticity.

So long as corporate action is necessitated for national self-preservation—so long as, to effect combined defense or offense, there is maintained that graduated subordination which ties all inferiors to superiors, as the soldier is tied to his officer—so long as there is maintained the relation of status which tends to fix men in the positions they are severally born to—there is insured a comparative rigidity of social organization. But, with the cessation of those needs that initiate and preserve the militant type of structure, and with the establishment of contract as the universal relation under which efforts are combined for mutual advantage, social organization loses its rigidity. No longer determined by the principle of inheritance, places and occupations are now determined by the principle of efficiency; and changes of struct-

ure follow when men, not bound to prescribed functions, acquire the functions for which they have proved themselves most fit. Easily modified in its arrangements, the industrial type of society is therefore one which adapts itself with facility to new requirements.

The other incidental result to be named is a tendency toward loss of economic autonomy.

While hostile relations with adjacent societies continue, each society has to be productively self-sufficing; but with the establishment of peaceful relations this need for self-sufficingness ceases. As the local divisions composing one of our great nations had, while they were at feud, to produce each for itself almost everything it required, but now, permanently at peace with one another, have become so far mutually dependent that no one of them can satisfy its wants without aid from the rest, so the great nations themselves, at present forced in large measure to maintain their economic autonomies, will become less forced to do this as war decreases, and will gradually become necessary to one another. While, on the one hand, the facilities possessed by each for certain kinds of production will render exchange mutually advantageous, on the other hand, the citizens of each will, under the industrial *régime*, tolerate no such restraints on their individualities as are implied by interdicts on exchange.

With the spread of the industrial type, therefore, the tendency is toward the breaking down of the divisions between nationalities, and the running through them of a common organization—if not under a single government, then under a federation of governments.

Such being the constitution of the industrial type of society to be inferred from its requirements, we have now to inquire what evidence is furnished by actual societies that approach toward this constitution accompanies the progress of industrialism.

As, during the peopling of the earth, the struggle for existence among societies, from small hordes up to great nations, has been nearly everywhere going on, it is, as before said, not to be expected that we should readily find examples of the social type appropriate to an exclusively industrial life. Ancient records join the journals of the day in proving that thus far no civilized or semi-civilized nation has fallen into circumstances making needless all social structures for resisting aggression, and from every region travelers' accounts bring evidence that, almost universally among the uncivilized, hostilities between tribes are chronic. Still, a few examples exist which show with tolerable clearness the outline of the industrial type in its rudimentary form—the form which it assumes where culture has made but little progress. We will consider these cases first, and then proceed to disentangle the traits distinctive of the industrial type as exhibited by large nations which have become predominantly industrial in their activities.

Among the Indian hills there are many tribes belonging to different races but alike in their partially nomadic habits. Mostly agricultural, their common practice is to cultivate a patch of ground while it yields average crops, and when it is exhausted to go elsewhere and repeat the process. They have fled before invading races, and have here and there found localities in which they are able to carry on their peaceful occupations unmolested: the absence of molestation being, in some cases, due to their ability to live in a malarious atmosphere, which is fatal to the Aryan races. Already, under other heads, I have referred to the Bodo and to the Dhimáls as wholly unmilitary, as having but nominal head-men, as being without slaves or social grades, and as aiding one another in their heavier undertakings; to the Todas, who, leading tranquil lives, are "without any of those bonds of union which man in general is induced to form from a sense of danger," and who settle their disputes by arbitration or by a council of five; to the Mishmies as being unwarlike, as having but nominal chiefs, and as administering justice by an assembly; and I have joined with these the case of a people remote in locality and race, the ancient Pueblos of North America, who, sheltering in their walled villages and fighting only when invaded, similarly joined with their habitual industrial life a free form of government: "The governor and his council are [were] annually elected by the people." Here I may add sundry kindred examples. As described in the Indian Government Report for 1869–'70, "the 'white Karens' are of a mild and peaceful disposition; . . . their chiefs are regarded as patriarchs, who have little more than nominal authority"; or, as said of them by Lieutenant McMahon, "they possess neither laws nor dominant authority." Instance again the "fascinating" Lepchas—not industrious, but yet industrial in the sense that their social relations are of the non-militant type. Though I find nothing specific said about the system under which they live in their temporary villages, yet the facts told us sufficiently imply its uncoercive character. They have no castes; "family and political feuds are alike unheard of among them"; "they are averse to soldiering"; they prefer taking refuge in the jungle and living on wild food "to enduring any injustice or harsh treatment"—traits which negative ordinary political control. Take next the "quiet, inoffensive" Santals, who, though they fight if need be with infatuated bravery to resist aggression, are essentially unaggressive. These people "are industrious cultivators, and enjoy their existence unfettered by caste." Though, having become tributaries, there habitually exists in each village a head appointed by the Indian Government to be responsible for the tribute, etc., yet the nature of their indigenous government remains sufficiently clear: while there is a patriarch who is honored, but who rarely interferes, "every village has its council-place . . . where the committee assemble and discuss the affairs of the village and its inhabitants. All petty disputes, both of a civil and crimi-

nal nature, are settled there." What little is told us of tribes living in the Shervaroy Hills is, so far as it goes, to like effect. Speaking generally of them, Shortt says they "are essentially a timid and harmless people, addicted chiefly to pastoral and agricultural pursuits"; and, more specifically describing one division of them, he says, "They lead peaceable lives among themselves, and any dispute that may arise is usually settled by arbitration." Then, to show that these social traits are not peculiar to any one variety of man, but are dependent on conditions, may be recalled the before-named instance of the Papuan Arafuras, who, without any divisions of rank or any hereditary chieftainship, lead harmonious lives controlled only by the decisions of their assembled elders. In all which cases we may discern the leading traits above indicated as proper to societies not impelled to corporate action by war. Strong centralized control not being required, such government as exists is exercised by a council informally approved—a rude representative government; class distinctions do not exist, or are but faintly indicated—the relation of *status* is absent; whatever transactions take place between individuals are by agreement, and the function which the ruling body has to perform is substantially limited to protecting private life by settling such disputes as arise and inflicting mild punishments for the small offenses which occur.

Difficulties meet us when, turning to civilized societies, we seek in them for the traits of the industrial type. Consolidated and organized as they have all been by wars actively carried on throughout the earlier periods of their existence, and mostly continued down to comparatively recent times, and having simultaneously been developing within themselves organizations for producing and distributing commodities, which have little by little become contrasted with those proper to militant activities, the two are everywhere presented so mingled that clear separation of the first from the last is, as said at the outset, scarcely practicable. Radically opposed, however, as is compulsory coöperation, the organizing principle of the militant type, to voluntary coöperation, the organizing principle of the industrial type, we may, by observing the decline of institutions exhibiting the one, recognize, by implication, the growth of institutions exhibiting the other. Hence, if, in passing from the first states of civilized nations, in which war is the business of life, to states in which hostilities are but occasional, we simultaneously pass to states in which the ownership of the individual by his society is not so constantly and strenuously enforced, in which the subjection of rank to rank is mitigated, in which political rule is no longer autocratic, in which the regulation of citizens' lives is diminished in range and rigor, while the protection of them increased, we are by implication shown the traits of a developing industrial type. Comparisons of several kinds disclose results which unite in verifying this truth.

Take first the contrast between the early condition of the more civilized European nations at large and their later condition. Setting out from the dissolution of the Roman Empire, we observe that for many centuries, during which conflicts were effecting consolidations, and dissolutions, and reconsolidations in endless variety, such energies as were not directly devoted to war were devoted to little else than supporting the organizations which carried on war: the working part of each community did not exist for its own sake, but for the sake of the fighting part. While militancy was thus high and industrialism undeveloped, the reign of superior force, continually being established by societies one over another, was equally displayed within each society. From slaves and serfs, through vassals of different grades up to dukes and kings, there was an enforced subordination by which the individualities of all were greatly restricted. And, at the same time that, to carry on external aggression or resistance, the ruling power in each group sacrificed the personal claims of its members, the function of defending its members from one another was in but small degree discharged by it: they were left to defend themselves. If with these traits of European societies in mediæval times we compare their traits in modern times, we see the following essential differences. First, with the formation of nations covering large areas, the perpetual wars within each area have ceased; and, though the wars which from time to time occur are on larger scales, they are less frequent, and they are no longer the business of all freemen. Second, there has grown up in each country a relatively large population which carries on production and distribution for its own benefit; so that, whereas, of old, the working part existed for the benefit of the fighting part, now the fighting part exists mainly for the benefit of the working part—exists ostensibly to protect it in the quiet pursuit of its ends. Third, the system of *status*, having under some of its forms disappeared and under others become greatly mitigated, has been almost universally replaced by the system of contract. Only among those who, by choice or by conscription, are incorporated in the militant organization does the system of *status*, in its primitive rigor, still hold so long as they remain in this organization. Fourth, with this decrease of compulsory coöperation and increase of voluntary coöperation, there have diminished or ceased many minor restraints over individual actions. Men are less tied to their localities than they were; they are not obliged to profess certain religious opinions; they are less debarred from expressing their political views; they no longer have their dresses and modes of living dictated to them; they are comparatively little restrained from forming private combinations and holding meetings for one or other purpose—political, religious, social. Fifth, while the individualities of citizens are less aggressed upon by public agency, they are more protected by public agency against aggression. Instead of a *régime* under which individuals rectified their private wrongs by force as well as they

could, or else bribed the ruler, general or local, to use his power in their behalf, there has come a *régime* under which, while much less self-protection is required, a chief function of the ruling power and its agents is to administer justice. In all ways, then, we are shown that, with this relative decrease of militancy and relative increase of industrialism, there has been a change from a social order in which individuals exist for the benefit of the state to a social order in which the state exists for the benefit of individuals.

When, instead of contrasting early European communities at large with European communities at large as they now exist, we contrast the one in which industrial development has been less impeded by militancy with those in which it has been more impeded by militancy, parallel results are apparent. Between our own society and Continental societies, as, for example, France, the differences which have gradually arisen may be cited in illustration. After the conquering Normans had spread over England, there was established here a much greater subordination of local rulers to the general ruler than there existed elsewhere; and, as a result, there was not nearly so much internal dissension. Says Hallam, speaking of this period, "We read very little of private wars in England." Though from time to time there were rebellions, and under Stephen a serious one, and though there were occasional fights between nobles, yet for some hundred and fifty years, up to the time of King John, the subjection maintained secured comparative order. Further, it is to be noted that such general wars as occurred were mostly carried on abroad; descents on our coasts were few and unimportant, and conflicts with Wales, Scotland, and Ireland, entailed but few intrusions on English soil. Consequently, there was a relatively small hindrance to industrial life and the growth of social forms appropriate to it. Meanwhile, the condition of France was widely different. During this period and long after, besides wars with England (mostly fought out on French soil) and wars with other countries, there were going on everywhere local wars. From the tenth to the fourteenth century perpetual fights between suzerains and their vassals occurred, as well as fights of vassals with one another. Not until toward the middle of the fourteenth century did the king begin greatly to predominate over the nobles; and only in the fifteenth century was there established a supreme ruler strong enough to prevent the quarrels of local rulers. How great was the consequent repression of industrial development may be inferred from the exaggerated language of an old writer, who says of this period during which the final struggle of monarchy with feudalism was going on, that "agriculture, traffic, and all the mechanical arts ceased." Such being the contrast between the small degree in which industrial life was impeded by war in England and the great degree in which it was impeded by war in France, let us ask, What were the political contrasts which arose? The first fact to be noted is that in the

middle of the thirteenth century there began in England a mitigation of villanage, by limitation of labor-services and commutation of them for money, and that in the fourteenth century the transformation of a servile into a free population had in great measure taken place; while in France, as in other Continental countries, the old condition survived and became worse. As Mr. Freeman says of this period, "In England villanage was on the whole dying out, while in many other countries it was getting harder and harder." Besides this spreading substitution of contract for *status*, which, taking place first in the industrial centers, the towns, afterward went on in the rural districts, there was going on an analogous enfranchisement of the noble class: the enforced military obligations of vassals were more and more replaced by money payments of scutages, so that, by King John's time, the fighting-services of the upper class had been to a great extent compounded for, like the labor-services of the lower class. After diminished restraints over persons, there came diminished invasions of property by the charter, arbitrary tallages on towns and non-military king's tenants were checked; and, while the aggressive actions of the state were thus decreased, its protective actions were extended: provisions were made that justice should be neither sold, delayed, nor denied. All which changes were toward those social arrangements which we see characterize the industrial type. Then, in the next place, we have the subsequently-occurring rise of a representative government; which, as shown in a preceding chapter by another line of inquiry, is at once the product of industrial growth and the form proper to the industrial type. But in France none of these changes took place. Villanage remaining unmitigated, continued to comparatively late times; compounding for military obligation of vassal to suzerain was less general; and, when there arose tendencies toward the establishment of an assembly expressing the popular will, they proved abortive. Detailed comparisons of subsequent periods and their changes would detain us too long: it must suffice to indicate the leading facts. Beginning with the date at which, under the influences just indicated, parliamentary government was finally established in England, we find that for a century and a half, down to the Wars of the Roses, the internal disturbances were few and unimportant compared with those which took place in France; while at the same time (remembering that the wars between England and France, habitually taking place on French soil, affected the state of France more than that of England) we note that France carried on serious wars with Flanders, Castile, and Navarre, besides the struggle with Burgundy; the result being that, while in England popular power as expressed by the House of Commons became settled and increased, such power as the States-General had acquired in France dwindled away. Not forgetting that by the Wars of the Roses, lasting over thirty years, there was initiated a return toward absolutism, let us

contemplate the contrasts which subsequently arose. For a century and a half after these civil conflicts ended, there were but few and trivial breaches of internal peace, while such wars as went on with foreign powers, not numerous, took place as usual out of England; and during this period the retrograde movement which the Wars of the Roses set up was reversed and popular power greatly increased; so that, in the words of Mr. Bagehot, "the slavish Parliament of Henry VIII grew into the murmuring Parliament of Queen Elizabeth, the mutinous Parliament of James I, and the rebellious Parliament of Charles I." Meanwhile France, during the first third of this period, had been engaged in almost continuous external wars with Italy, Spain, and Austria; while during the remaining two thirds it suffered from almost continuous internal wars, religious and political; the accompanying result being that, notwithstanding resistances from time to time made, the monarchy became increasingly despotic. To make fully manifest the different social types that had been evolved under these different conditions, we have to compare not only the respective political constitutions but also the respective systems of social control. Observe what these were at the time when there commenced the reaction which ended in the French Revolution. In harmony with the theory of the militant type, that the individual is, in life, liberty, and property, owned by the state, the monarch had come to be universal proprietor. Giving nothing in return, he took whatever houses and lands he pleased; and the burdens he imposed on land-owners were so grievous that some of them preferred abandoning their estates to paying. Then, besides the taking of property by the state, there was the taking of labor. One fourth of the working-days in the year went as *corvées*, due to the king and in part to the feudal lord. Such liberties as were allowed had to be paid for again and again; the municipal privileges of towns being seven times in twenty-eight years withdrawn and resold to them. Military services of nobles and people were imperative to whatever extent the king demanded; and conscripts were drilled under the lash. At the same time that the subjection of the individual to the state was pushed to such an extreme by exactions of money and services that the impoverished people cut the grain while it was green, ate grass, and died of starvation in millions, the state did little to guard their persons and homes. Contemporary writers enlarge on the multitudinous highway robberies, burglaries, assassinations, and torturings of people to discover their hoards; herds of vagabonds, levying black-mail, roamed about, and when, as a remedy, penalties were imposed, innocent persons denounced as vagabonds were sent to prison without evidence. There was no personal security either against the ruler or against powerful enemies: in Paris there were some thirty prisons where untried and unsentenced people might be incarcerated; and the "brigandage of justice" annually cost suitors forty to sixty millions of francs. While the state, aggressing on citizens to such

extremes, thus failed to protect them against one another, it was active in regulating their private lives and labors. Religion was dictated to the extent that Protestants were imprisoned, sent to the galleys, or whipped, and their ministers hanged. The quantity of salt (on which there was a heavy tax) to be consumed by each person was prescribed; as were also the modes of its use. Industry of every kind was supervised. Certain crops were prohibited; and vines grown on soils considered unfit were destroyed. The wheat that might be bought at market was limited to two bushels; and sales took place in presence of dragoons. Manufacturers were regulated in their processes and products to the extent that there was destruction of improved appliances and of goods not made according to law, as well as penalties upon inventors. Regulations succeeded one another so rapidly that amid their multiplicity government agents found it difficult to carry them out; and with the increasing official orders came increasing swarms of public functionaries. Turning now to England at the same period, we see that along with progress toward the industrial type of political structure, carried to the extent that the House of Commons had become the predominant power, there had gone on a progress toward the accompanying social system. Though the subjection of the individual to the state was considerably greater than now, it was far less than in France. His private rights were not sacrificed in the same unscrupulous way; and he was not in danger of a *lettre de cachet*. Though justice was very imperfectly administered, still it was not administered so wretchedly; there was a fair amount of personal security, and aggressions on property were kept within bounds. The disabilities of Protestant dissenters were diminished early in the century; and, later on, those of Catholics. Considerable freedom of the press was acquired, showing itself in the discussion of political questions as well as in the publication of parliamentary debates; and, about the same time, there came free speech in public meetings. While thus the state aggressed upon the individual less and protected him more, it interfered to a smaller extent with his daily transactions. Though there was much regulation of commerce and industry, yet it was pushed to no such extreme as that which in France subjected agriculturists, manufacturers, and merchants, to an army of officials who directed their acts at every turn. In brief, the contrast between our state and that of France was such as to excite the surprise and admiration of various French writers of the time, from whom Mr. Buckle quotes numerous passages showing this.

Most significant of all, however, are the changes in England itself, first retrogressive and then progressive, that occurred during the war period which extended from 1775 to 1815, and during the subsequent period of peace. At the end of the last century and the beginning of this, reversion toward ownership of the individual by the society had gone a long way. "To statesmen, the state, as a unit, was all in all,

and it is really difficult to find any evidence that the people were thought of at all, except in the relation of obedience." "The Government regarded the people with little other view than as a taxable and soldier-yielding mass." While the militant part of the community had greatly developed, the industrial part had approached toward the condition of a permanent commissariat. By conscription and by press-gangs was carried to a relatively vast extent that sacrifice of the citizen in life and liberty which war entails; and the claims to property were trenched upon by merciless taxation, weighing down the middle classes so grievously that they had greatly to lower their rate of living, while the people at large were so distressed (partly no doubt by bad harvests) that "hundreds ate nettles and other weeds." With these major aggressions upon the individual by the state went numerous minor aggressions. Irresponsible agents of the executive were empowered to suppress public meetings and seize their leaders; death being the punishment for those who did not disperse when ordered. Libraries and news-rooms could not be opened without license; and it was penal to lend books without permission. There were "strenuous attempts made to silence the press"; and booksellers dared not publish works by obnoxious authors. "Spies were paid, witnesses were suborned, juries were packed, and, the *habeas corpus* act being constantly suspended, the crown had the power of imprisoning without inquiry and without limitation." While the Government taxed and coerced and restrained the citizen to this extent, its protection of him was inefficient. It is true that the penal code was made more extensive and more severe: the definition of treason was enlarged, and many transgressions were made capital which were not capital before; so that there was "a vast and absurd variety of offenses for which men and women were sentenced to death by the score": there was "a devilish levity in dealing with human life." But at the same time there was not increase but rather decrease of security. As says Mr. Pike, in his "History of Crime," "It became apparent that the greater the strain of the conflict the greater is the danger of a reaction toward violence and lawlessness." Turn now to the opposite picture. After recovery from the prostration which prolonged wars had left, and the dying away of those social perturbations caused by impoverishment, there began a revival of traits proper to the industrial type. Coercion of the citizen by the state decreased in various ways. Voluntary enlistment replaced compulsory military service; and there disappeared some minor restraints over personal freedom, as instance the repeal of laws which forbade artisans to travel where they pleased, and which interdicted trades-unions. With these manifestations of greater respect for personal freedom may be joined those shown in the amelioration of the penal code: the public whipping of females being first abolished, then the long list of capital offenses being reduced until there finally remained but one, and eventually the pillory and impris-

onment for debt being abolished. Such penalties on religious independence as remained disappeared; first by removal of those directed against Protestant dissenters, and then of those which weighed on the Catholics, and then of some which told specially against Quakers and Jews. By the Parliamentary Reform Bill and Municipal Reform Bill, vast numbers were removed from the subject classes to the governing classes. Interferences with the business-transactions of citizens were diminished by allowing free trade in bullion, by permitting joint-stock banks, by abolishing multitudinous restrictions on the importation of commodities—leaving eventually but few which pay duty. And, while by these and kindred changes, such as the removal of restraining burdens on the press, impediments to the free action of the citizen were decreased, the protective action of the state was increased. By a greatly-improved police system, by county courts, and so forth, personal safety and claims to property were better secured.

Not to elaborate the argument further by adding the case of the United States, which repeats with minor differences the same relations of phenomena, the evidence given adequately supports the proposition laid down. Amid all the complexities and perturbations, comparisons show us with sufficient clearness that, in actually-existing societies, those traits which we inferred must distinguish the industrial type show themselves clearly in proportion as the social activities are predominantly characterized by exchange of services under agreement.

As in the last chapter we noted the traits of character proper to the members of a society which is habitually at war, so here we have to note the traits of character proper to the members of a society occupied exclusively in peaceful pursuits. Already in delineating above, the rudiments of the industrial type of social structure as exhibited in certain small groups of unwarlike peoples, some indications of the accompanying personal qualities have been given; but it will be well now to emphasize these and add to them, before observing the kindred personal qualities in the more advanced industrial communities.*

Absence of a centralized coercive rule, implying as it does feeble political restraints exercised by the society over its units, is accompanied by a strong sense of individual freedom and a determination to maintain it. The amiable Bodo and Dhimáls, as we have seen, resist "injunctions injudiciously urged with dogged obstinacy."[1] The peaceful Lepchas "undergo great privations rather than submit to oppression or injustice."[2] The "simple-minded Santál" has a "strong natural sense of justice, and, should any attempt be made to coerce

* Though, as already explained, the references to authorities have been reserved until the final publication of these chapters, yet, as the facts quoted in the succeeding paragraphs are such as to excite surprise, or, it may be, doubt, I think it well to here give at once the means of verification: [1] Hodgson in "Journal Asiatic Society," Bengal, xviii, 746. [2] Campbell in "Journal Ethnological Society," for July, 1869. [3] Hunter's "Annals

him, he flies the country."[3] And so of a tribe not before mentioned, the Jakuns of the South Malayan Peninsula, who, described as "entirely inoffensive," personally brave but peaceful, and as under no control but that of popularly appointed heads who settle their disputes, are also described as "extremely proud": the so-called pride being exemplified by the statement that their remarkably good qualities "induced several persons to make attempts to domesticate them, but such essays have generally ended in the Jakuns' disappearance on the slightest coercion."[4]

With a strong sense of their own claims, these unwarlike men display unusual respect for the claims of others. This is shown in the first place by the rarity of personal collisions among them. Hodgson says that the Bodo and the Dhimáls "are void of all violence toward their own people or toward their neighbors."[5] Of the peaceful tribes of the Neilgherry Hills, Colonel Ouchterlony writes, "Drunkenness and violence are unknown among them."[6] Campbell remarks of the Lepchas, that "they rarely quarrel among themselves."[7] The Jakuns, too, "have very seldom quarrels among themselves"; and such disputes as arise are settled by their popularly-chosen heads "without fighting or malice."[8] And similarly the Arafuras "live in peace and brotherly love with one another."[9] Further, in the accounts of these peoples we read nothing about the *lex talionis*. In the absence of hostilities with adjacent groups, there does not exist within each group that "sacred duty of blood-revenge" universally recognized in militant tribes and nations. Still more significantly, we find evidence of the opposite doctrine and practice. Says Campbell of the Lepchas: "They are singularly forgiving of injuries; . . . making mutual amends and concessions."[10]

Naturally, with respect for others' individualities thus shown, goes respect for their claims to property. Already, in the preliminary chapter, I have quoted testimonies to the great honesty of the Bodo

of Rural Bengal," i, 209; Sherville in "Journal Asiatic Society," xx, 554. [4] Rev. P. Favre in "Journal of Indian Archipelago," ii, 266, 267. [5] Hodgson in "Journal Asiatic Society," xviii, 746. [6] Colonel Ouchterlony, "Memoir of Survey of the N. H.," page 69. [7] Campbell in "Journal Ethnological Society," for July, 1869. [8] Rev. P. Favre in "Journal of Indian Archipelago," ii, 266. [9] Earl's translation of Kolff's "Voyages of the Dom-ga," page 161. [10] Campbell in "Journal Ethnological Society," of July, 1869. [11] Hooker's "Himalayan Journals," i, 175, 176. [12] Hunter's "Annals of Rural Bengal," i, 217. [13] Dalton's "Des. Ethnology," page 206. [14] Shortt's "Hill Ranges of S. S. India," part i, 9. [15] Ditto, part ii, 7, 8. [16] Favre in "Journal of Indian Archipelago," ii, 266. [17] Juke's "Voyage of Her Majesty's Ship Fly," i, 219, 220. [18] Hodgson in "Journal Asiatic Society," xviii, 745. [19] Hunter, "Annals of Rural Bengal," i, 209, 210. [20] Hooker's "Himalayan Journal," i, 175, 176; 129, 130. [21] Favre in "Journal of Indian Archipelago," ii, 266. [22] Earl's Kolff, 164. [23] Captain St. John's "The Wild Coasts of Nipon," 142. [24] Miss Bird's "Unbeaten Tracks in Japan," ii, 103; 74. [25] Hooker's "Himalayan Journal," i, 134. [26] Hunter's "Annals of Rural Bengal," i, 208. [27] Hodgson in "Journal Asiatic Society," xviii, 708. [28] Hunter's "Annals of Rural Bengal," i, 217. [29] Hodgson's "Essays," i, 150. [30] "Journal Ethnological Society," vii, 241.

and the Dhimáls, the Lepchas, the Santáls, the Todas, and other peoples kindred in their form of social life ; and here I may add further ones. Of the Lepchas, Hooker says, "In all my dealings with these people, they proved scrupulously honest." [11] "Among the pure Santáls," writes Hunter, "crime and criminal officers are unknown" ; [12] while of the Hos, belonging to the same group as the Santáls, Dalton says, "A reflection on a man's honesty or veracity may be sufficient to send him to self-destruction." [13] In like manner Shortt testifies that "the Todas, as a body, have never been convicted of heinous crimes of any kind" ; [14] and, concerning other peaceful tribes of the Shervaroy Hills, he states that "crime of a serious nature is unknown among them." [15] Again, of the Jakuns we read that "they are never known to steal anything, not even the most insignificant trifle." [16] And so of certain natives of Malacca who "are naturally of a commercial turn," Jukes writes : "No part of the world is freer from crime than the district of Malacca . . . a few petty cases of assault ; or of disputes about property . . . are all that occur." [17]

Thus free from the coercive rule which warlike activities necessitate, and without that sentiment which makes the needful subordination possible—thus maintaining their own claims while respecting the like claims of others—thus devoid of the vengeful feelings which aggressions without and within the tribe generate—these peoples, instead of the bloodthirstiness, the cruelty, the selfish trampling upon inferiors, characterizing militant tribes and societies, display, in unusual degrees, the humane sentiments. Insisting on their amiable qualities, Hodgson describes the Bodo and the Dhimáls as being "almost entirely free from such as are unamiable." [18] Remarking that "while courteous and hospitable he is firm and free from cringing," Hunter tells us of the Santál that he thinks "uncharitable men" will suffer after death. [19] Saying that the Lepchas are "ever foremost in the forest or on the bleak mountain, and ever ready to help, to carry, to encamp, collect, or cook," Hooker adds, "They cheer on the traveler by their unostentatious zeal in his service" ; and he also adds that "a present is divided equally among many, without a syllable of discontent or grudging look or word." [20] Of the Jakuns, too, Favre tells us that "they are generally kind, affable, inclined to gratitude and to beneficence" : their tendency being not to ask favors but to confer them. [21] And then of the peaceful Arafuras we learn from Kolff that—

"They have a very excusable ambition to gain the name of rich men, by paying the debts of their poorer fellow-villagers. The officer [M. Bik], whom I quoted above, related to me a very striking instance of this. At Affora he was present at the election of the village chief, two individuals aspiring to the station of Orang Tua. The people chose the elder of the two, which greatly afflicted the other, but he soon afterward expressed himself satisfied with the choice the people had made, and said to M. Bik, who had been sent there on a commission, 'What reason have I to grieve? Whether I am Orang Tua or not, I still have it

in my power to assist my fellow-villagers.' Several old men agreed to this, apparently to comfort him. Thus the only use they make of their riches is to employ it in settling differences." [23]

And these various evidences may be enforced by yet others contained in works on Japan, published since these chapters were commenced. Giving a passing notice to the fact that Captain St. John, speaking of the "goodness and kindness" of the people in the "wild part of Japan," where they had not seen Europeans, says, "I always found, the farther from the open ports I went, the nicer in every way were the people," [24] I pass on to the testimony of Miss Bird concerning the Ainos. These appear to be an aboriginal race, who, like the Hill tribes of India, have retired before an invading race. According to this lady traveler, "they have no traditions of internecine strife, and the art of war seems to have been lost long ago." They are "truthful," "gentle," "considerate"; and when a house was burned down all the men joined to rebuild it. They are "punctiliously honest" in all their transactions; are very anxious to give; and when induced to sell would accept only a moiety of the amount offered. Describing generally their traits of nature she says, "I hope I shall never forget the music of their low sweet voices, the soft light of their mild brown eyes, and the wonderful sweetness of their smile." [25]

With these superiorities of the social relations in permanently peaceful tribes go superiorities of their domestic relations. As I have before pointed out, while the *status* of women is habitually very low in tribes given to war and in more advanced militant societies, it is habitually very high in these primitive peaceful societies. The Bodo and the Dhimáls, the Kocch, the Santáls, the Lepchas, are monogamic, as were also the Pueblos; and along with their monogamy habitually goes a superior sexual morality. Of the Lepchas Hooker says, "The females are generally chaste, and the marriage tie is strictly kept." [26] Among the Santáls, "unchastity is almost unknown" and "divorce is rare." [26] By the Bodo and the Dhimáls, "polygamy, concubinage, and adultery are not tolerated:" "chastity is prized in man and woman, married and unmarried." [27] Further it is to be noted that, among these peoples, the behavior to women is extremely good. "The Santál treats the female members of his family with respect;" [28] the Bodo and the Dhimáls "treat their wives and daughters with confidence and kindness: they are free from all out-door work whatever." [29] And even among the Todas, low as are the forms of their sexual relations, "the wives are treated by their husbands with marked respect and attention." [30] Moreover, we are told concerning sundry of these unwarlike peoples that the *status* of children is also high; and there is none of that distinction of treatment between boys and girls which characterizes militant tribes.*

* In a "Symposium" published in the "Nineteenth Century" for April and May, 1877, was discussed "the influence upon morality of a decline in religious belief": the ques-

Of course, on turning to civilized peoples to observe the form of individual character which accompanies the industrial form of society, we encounter the difficulty that the personal traits proper to industrialism are, like the social traits, mingled with those proper to militancy. It is manifestly thus with ourselves. A nation which, besides its occasional serious wars, is continually carrying on small wars with uncivilized tribes; a nation which is mainly ruled in Parliament and through the press by men whose school-discipline led them during six days in the week to take Achilles for their hero, and on the seventh to admire Christ; a nation which at its public dinners habitually toasts its army and navy before toasting its legislative bodies—has not so far emerged out of militancy that we can expect either the institutions or the personal characters proper to industrialism to be shown with clearness. In independence, in honesty, in truthfulness, in humanity, its citizens

tion eventually raised being whether morality can exist without religion. Not much difficulty in answering this question will be felt by those who, from the conduct of these rude tribes, turn to that of Europeans during the Christian era, with its innumerable and immeasurable public and private atrocities, its bloody aggressive wars, its ceaseless family vendettas, its bandit barons and fighting bishops, its massacres, political and religious, its torturings and burnings, its all-pervading crime from the assassinations of and by kings down to the lyings and petty thefts of slaves and serfs. Nor do the contrasts between our own conduct at the present time and the conduct of these so-called savages leave us in doubt concerning the right answer. When, after reading police reports, criminal assize proceedings, accounts of fraudulent bankruptcies, etc., which, in our journals, accompany advertisements of sermons and reports of religious meetings, we learn that the "amiable" Bodo and Dhimáls, who are so "honest and truthful," "have no word for God, for soul, for heaven, for hell" (though they have ancestor-worship and some derivative beliefs), we find ourselves unable to recognize the alleged connection. If side by side with narratives of bank frauds, railway jobbings, turf chicaneries, etc., among people who are anxious that the House of Commons should preserve its theism untainted, we place descriptions of the "fascinating" Lepchas, who are so "wonderfully honest," but who "profess no religion, though acknowledging the existence of good and bad spirits" (to the latter of whom only they pay any attention), we do not see our way to accepting the dogma which our theologians think so obviously true; nor will acceptance of it be made easier when we add the description of the conscientious Santál, who "never thinks of making money by a stranger," and "feels pained if payment is pressed upon him" for food offered; but concerning whom we are told that "of a supreme and beneficent God the Santál has no conception." Admission of the doctrine that right conduct depends on theological conviction becomes difficult on reading that the Veddahs, who are "almost devoid of any sentiment of religion" and have no idea "of a Supreme Being," nevertheless "think it perfectly inconceivable that any person should ever take that which does not belong to him, or strike his fellow, or say anything that is untrue." After finding that, among the select of the select who profess our established creed, the standard of truthfulness is such that the statement of a minister concerning Cabinet transactions is distinctly falsified by the statement of a seceding minister, and after then recalling the marvelous veracity of these godless Bodo and Dhimáls, Lepchas, and other peaceful tribes having kindred beliefs, going to such extent that an imputation of falsehood is enough to make one of the Hos destroy himself, we fail to see that in the absence of a theistic belief there can be no regard for truth. When, in a weekly journal specially representing the university culture shared in by our priests, we find a lament over the moral degradation shown in our treatment of the Boers; when we are held degraded because we have

are not likely to be the equals of the uncultured but peaceful peoples above described. All we may anticipate is an approach to these moral characteristics appropriate to a state undisturbed by international hostilities; and this we find.

In the first place, with progress of the *régime* of contract has come growth of independence. Daily exchange of services under agreement, involving at once the maintenance of personal claims and respect for the claims of others, has fostered a normal self-assertion and consequent resistance to unauthorized power. The facts that the word "independence" in its modern sense was not in use among us before the middle of the last century, and that on the Continent independence is less markedly displayed, suggest the connection between this trait and a developing industrialism. The trait is shown in the multitudinousness of religious sects, in the divisions of political parties, and in minor

not slaughtered them for successfully resisting our trespasses; when we see that the "sacred duty of blood-revenge," which the cannibal savage insists upon, is insisted upon by those to whom the Christian religion was daily taught throughout their education; and when, from contemplating this fact, we pass to the fact that the unreligious Lepchas "are singularly forgiving of injuries"—the assumed relation between humanity and theism appears anything but congruous with the evidence. If with the ambitions of our church-going citizens, who (not always in very honorable ways) strive to get fortunes that they may make great displays, and gratify themselves by thinking that at death they will "cut up well," we compare the ambitions of the Arafuras, among whom wealth is desired that its possessor may pay the debts of poorer men and settle differences, we are obliged to reject the assumption that "brotherly love" can exist only as a consequence of divine injunctions, with promised rewards and threatened punishments; for of these Arafuras we read that, "of the immortality of the soul they have not the least conception. To all my inquiries on this subject they answered, 'No Arafura has ever returned to us after death, therefore we know nothing of a future state, and this is the first time we have heard of it.' Their idea was, when you are dead there is an end of you. Neither have they any notion of the creation of the world. They only answered, 'None of us were aware of this, we have never heard anything about it, and therefore do not know who has done it all.'" Once more, when, after indicating the Ainos' fear of ghosts and some allied superstitions, but saying that "it is nonsense to write of the religious ideas of a people who have none," Miss Bird tells us of these "kind and delightful savages" that for something she wished to buy they would accept only half what she offered; when by contrast we are reminded of Jews who, after three thousand years of monotheism, lend money at enormous rates of interest and ruin their clients by merciless enforcement of their claims—we are shown that the goodness which may exist without theistic belief is as remarkable as the badness which may exist along with it. That which the facts show us is that, so far as men's moral states are concerned, theory is almost nothing and practice is almost everything. No matter how high their nominal creed, nations given to political burglaries, to get "scientific frontiers" and the like, will have among their members many who "annex" others' goods for their own convenience; and with the organized crime of aggressive war will go criminality in the behavior of one citizen to another. Conversely, as these uncultivated tribes prove, no matter how devoid they are of religious beliefs, those who, generation after generation remaining unmolested, inflict no injuries upon others, have their altruistic sentiments fostered by the sympathetic intercourse of a peaceful daily life, and display the resulting virtues. We need teaching that it is impossible to join injustice and brutality abroad with justice and humanity at home. What a pity these heathens can not be induced to send missionaries among the Christians!

ways by the absence of those "schools" in art, philosophy, etc., which, among Continental peoples, are formed by the submission of disciples to an adopted master. That in England men show, more than elsewhere, a jealousy of dictation, and a determination to act as they think fit, will not, I think, be disputed.

The diminished subordination to authority, which is the obverse of this independence, of course implies decrease of loyalty. Worship of the monarch, at no time with us reaching to the height it did in France early in the last century, or in Russia down to recent times, has now changed into a respect depending very much on the monarch's personal character. Our days witness no such extreme servilities of expression as were used by ecclesiastics in the dedication of the Bible to King James, nor any such exaggerated adulations as those addressed to George III by the House of Lords. The doctrine of divine right has long since died away; belief in an indwelling supernatural power (implied by the touching for king's evil, etc.) is named as a curiosity of the past; and the monarchical institution has come to be defended on grounds of expediency. So great has been the decrease of this sentiment which, under the militant *régime*, attaches subject to ruler, that nowadays the conviction commonly expressed is that, should the throne be occupied by a Charles II or a George IV, there would probably result a republic. And this change of feeling is shown in the attitude toward the Government as a whole. For not only are there many who dispute the authority of the state in respect of sundry matters besides religious beliefs, but there are some who passively resist what they consider unjust exercises of its authority, and pay fines or go to prison rather than submit.

As this last fact implies, along with decrease of loyalty has gone decrease of faith, not in monarchs only but in governments. Such belief in royal omnipotence as existed in ancient Egypt, where the power of the ruler was supposed to extend to the other world, as it is even now supposed to do in China, has had no parallel in the West; but still, among European peoples in past times, that confidence in the soldier-king essential to the militant type displayed itself, among other ways, in exaggerated conceptions of his ability to cure evils, achieve benefits, and arrange things as he willed. If we compare present opinion among ourselves with opinion in early days, we find a decline in these credulous expectations. Though, during the late retrograde movement toward militancy, state-power has been invoked for various ends, and faith in it has increased; yet, up to the commencement of this reaction, a great change had taken place in the other direction. After the repudiation of a state-enforced creed, there came a denial of the state's capacity for determining religious truth, and a growing movement to relieve it from the function of religious teaching, held to be alike needless and injurious. Long ago it had ceased to be thought that Government could do any good by regulating people's

food, clothing, and domestic habits; and over the multitudinous processes carried on by producers and distributors, constituting immensely the larger part of our social activities, we no longer believe that legislative dictation is beneficial. Moreover, every newspaper, by its criticisms on the acts of ministers and the conduct of the House of Commons, betrays the diminished faith of citizens in their rulers. Nor is it only by contrasts between past and present among ourselves that we are shown this trait of a more developed industrial state. It is shown by kindred contrasts between opinion here and opinion abroad. The speculations of social reformers in France and in Germany prove that the hope for benefits to be achieved by state-agency is far higher with them than with us.

Along with decrease of loyalty and concomitant decrease of faith in the powers of governments has gone decrease of patriotism—patriotism, that is, under its original form. To fight "for king and country" is an ambition which nowadays occupies but a small space in men's minds; and though there is among us a majority whose sentiment is represented by the exclamation, "Our country, right or wrong!" yet there are large numbers whose desire for human welfare at large so far overrides their desire for national prestige that they object to sacrificing the first to the last. The spirit of self-criticism, which in sundry respects leads us to make unfavorable comparisons between ourselves and Continental nations, leads us more than heretofore to blame ourselves for wrong conduct to other peoples. The denunciations uttered by many on our dealings with the Afghans, the Zooloos, and the Boers, show that there is a large amount of the feeling reprobated by the "Jingo"-class as unpatriotic.

That adaptation of individual nature to social needs which, in the militant state, makes men glory in war and despise peaceful pursuits, has partially brought about among us a converse adjustment of the sentiments. The occupation of the soldier has ceased to be so much honored, and that of the civilian is more honored. During the forty years' peace, the popular sentiment became such that "soldiering" was spoken of contemptuously; and those who enlisted, habitually the idle and the dissolute, were commonly regarded as having completed their disgrace. Similarly in America before the late civil war, such small military gatherings and exercises as from time to time occurred, excited general ridicule. Meanwhile, we see that labors, bodily and mental, useful to self and others, have come to be not only honorable, but in a considerable degree imperative. In America the adverse comments on one who does nothing, almost force him into some active pursuit; and among ourselves the respect for industrial life has become such that men of high rank put their sons into business.

While, as we saw, the compulsory coöperation proper to militancy forbids, or greatly discourages, individual initiative, the voluntary coöperation which distinguishes industrialism gives free scope to

individual initiative, and develops it by letting enterprise bring its normal advantages. Those who are successfully original in idea and act, prospering and multiplying in greater degrees than others, produce, in course of time, a general type of nature ready to undertake new things. The speculative tendencies of English and American capitalists, and the extent to which large undertakings, both at home and abroad, are carried out by them, sufficiently indicate this trait of character. Though, along with considerable qualification of militancy by industrialism on the Continent, there has occurred there, too, an extension of private enterprise, yet the fact that, while many towns in France and Germany have been supplied with gas and water by English companies, there is in England but little of kindred achievement by foreign companies, shows that, among the more industrially-modified English, individual initiative is more decided.

There is evidence that the decline of international hostilities, going as it does with the decline of hostilities between families and between individuals, is followed by a weakening of revengeful sentiments. This is implied by the fact that in our own country the more serious of these private wars early ceased, leaving only the less serious in the form of duels, which also have at length ceased: their cessation coinciding with the recent great development of industrial life—a fact with which may be joined the fact that in the more militant societies, France and Germany, they have not ceased. So much among ourselves has the authority of the *lex talionis* waned, that a man, whose actions are known to be prompted by the wish for vengeance on one who has injured him, is reprobated rather than applauded.

With decrease of the aggressiveness shown in acts of violence and consequent acts of retaliation has gone decrease of the aggressiveness shown in criminal acts at large. That this change has been a concomitant of the change from a more militant to a more industrial state can not be doubted by one who studies the history of crime in England. Says Mr. Pike in his work on that subject, "The close connection between the military spirit and those actions which are now legally defined to be crimes has been pointed out, again and again, in the course of this history." If we compare a past age in which the effects of hostile activities had been less qualified by the effects of peaceful activities than they have been in our own age, we see a marked contrast in respect of the numbers and kinds of offenses against person and property. We have no longer any English buccaneers; wreckers have ceased to be heard of; and travelers do not now prepare themselves to meet highwaymen. Moreover, that flagitiousness of the governing agencies themselves, which was shown by the venality of ministers and members of Parliament, and by the corrupt administration of justice, has disappeared. With decreasing amount of crime has come increasing reprobation of crime. Biogra-

phies of pirate captains, suffused with admiration of their courage, no longer find a place in our literature; and the sneaking kindness for "gentlemen of the road" is, in our days, but rarely displayed. Many as are the transgressions which our journals report, they have greatly diminished; and, though in trading transactions there is much dishonesty (chiefly of the indirect sort), it needs but to read De Foe's "English Tradesman" to see how marked has been the improvement since his time. Nor must we forget that the change of character which has brought a decrease of unjust actions has brought an increase of beneficent actions; as seen in paying for slave emancipation, in nursing the wounded soldiers of our fighting neighbors, in philanthropic efforts of countless kinds.

As with the militant type, then, so with the industrial type, three lines of evidence converge to show us its essential nature. Let us set down briefly the several results, that we may observe the correspondences among them.

On considering what must be the traits of a society organized exclusively for carrying on internal activities, so as most efficiently to subserve the lives of citizens, we find them to be these: A corporate action, subordinating individual actions by uniting them in joint effort, is no longer requisite. Contrariwise, such corporate action as remains has for its end to guard individual actions against all interferences not necessarily entailed by mutual limitation: the type of society in which this function is best discharged being that which must survive, since it is that of which the members will most prosper. Excluding, as the requirements of the industrial type do, a despotic controlling agency, they imply, as the only congruous agency for achieving such corporate action as is needed, one formed of representatives who serve to express the aggregate will. The function of this controlling agency, generally defined as that of administering justice, is more specially defined as that of seeing that each citizen gains neither more nor less of benefit than his activities normally bring; and there is thus excluded all public action involving any artificial distribution of benefits. The *régime* of status proper to militancy having disappeared, the *régime* of contract which replaces it has to be universally enforced; and this negatives interferences between efforts and results by arbitrary appointment. Otherwise regarded, the industrial type is distinguished from the militant type as being not both positively regulative and negatively regulative, but as being negatively regulative only. With this restricted sphere for corporate action comes an increased sphere for individual action; and from that voluntary coöperation which is the fundamental principle of the type arise multitudinous private combinations, akin in their structures to the public combination of the society which includes them. Indirectly it results that a society of the industrial type is distinguished by plasticity; and also

that it tends to lose its economic autonomy, and to coalesce with adjacent societies.

The question next considered was, whether these traits of the industrial type as arrived at by deduction are inductively verified; and we found that in actual societies they are visible more or less clearly in proportion as industrialism is more or less developed. Glancing at those small groups of uncultured people who, wholly unwarlike, display the industrial type in its rudimentary form, we went on to compare the structures of European nations at large in early days of chronic militancy with their structures in modern days characterized by progressing industrialism; and we saw the differences to be of the kind implied. We next compared two of these societies, France and England, which were once in kindred states, but of which the one has had its industrial life much more repressed by its militant life than the other; and it became manifest that the contrasts which, age after age, arose between their institutions, were such as answer to the hypothesis. Lastly, limiting ourselves to England itself, and first noting how recession from such traits of the industrial type as had shown themselves occurred during a long war period, we observed how, during the subsequent long peace beginning in 1815, there were numerous and decided approaches to that social structure which we concluded must accompany developed industrialism.

We then inquired what type of individual nature accompanies the industrial type of society; with a view of seeing whether, from the character of the unit as well as from the character of the aggregate, confirmation is to be derived. Certain uncultured peoples, whose lives are passed in peaceful occupations, proved to be distinguished by independence, resistance to coercion, honesty, truthfulness, forgivingness, kindness. On contrasting the characters of our ancestors during more warlike periods with our own characters, we see that, with an increasing ratio of industrialism to militancy have come a rising independence, a less-marked loyalty, a smaller faith in governments, and a more qualified patriotism; and while, by enterprising action, by diminished faith in authority, by resistance to irresponsible power, there has been shown a strengthening assertion of individuality, there has accompanied it a growing regard for the individualities of others, as implied by the diminution of aggressions upon them and the multiplication of efforts for their welfare.

To prevent misapprehension it seems needful, before closing, to explain that these traits are to be regarded less as the immediate results of industrialism than as the remote results of non-militancy. It is not so much that a social life passed in peaceful occupations is positively moralizing, as that a social life occupied in war is positively demoralizing. Sacrifice of others to self is in the one incidental only; while in the other it is necessary. Such aggressive egoism as accompanies the industrial life is extrinsic; whereas the aggressive egoism

of the militant life is intrinsic. Though very generally unsympathetic, the exchange of services under agreement is now, to a considerable extent, and may be wholly, carried on with a due regard to the claims of others—may be constantly accompanied by a sense of benefit given as well as benefit received; but the slaying of antagonists, the burning of their houses, the appropriation of their territory, can not but be accompanied by vivid consciousness of injury done them, and a consequent brutalizing effect on the feelings—an effect wrought, not on soldiers only, but on those who employ them and contemplate their deeds with pleasure. This last form of social life, therefore, inevitably deadens the sympathies and generates a state of mind which prompts crimes of trespass; while the first form, allowing the sympathies free play, if it does not directly exercise them, favors the growth of altruistic sentiments and the resulting virtues.

## DETERIORATION OF AMERICAN OYSTER-BEDS.

By Lieutenant FRANCIS WINSLOW.

### I.

A WRITER in a recent number of "Lippincott's Magazine" has called attention to the failure of the oyster-beds of the New England and Middle States, to the deterioration of those lying in Southern waters, and to the necessity for some effort, either upon the part of the national or State Governments or by individuals, to maintain the supply of oysters in sufficient numbers to satisfy the large and increasing demand of the consumers. This very desirable end, it is suggested, can be obtained by a system of oyster-culture similar to that adopted by the French Government and by various foreign oyster companies. The author's statements of facts, especially those relating to the foreign fisheries, are both interesting and in accordance with what is known by those interested in and possessing knowledge of the history of the oyster-fishery, either in the United States or abroad. The inferences drawn from the statistics collected can be accepted as just, inasmuch as they relate to the destruction or deterioration of the American beds; but that they logically lead to a belief that oyster-culture in the United States, if conducted as in France, can either supply the demand or be financially successful, is open to serious question.

There is no doubt, as stated in the article at present under review, that the natural beds of the North are practically exhausted; neither is there any doubt of the greatly diminished production of the Southern beds—that is, those of Maryland and Virginia. That the area of

the latter has decreased is, however, improbable, the *estimates* of Governor Wise and of the officers of the "Merchants' and Mechanics' Exchange," of Norfolk, to the contrary, notwithstanding. Why the reduction of the area of the beds is considered improbable will be shown subsequently. The writer states various reasons for his belief in the early failure of the oyster-supply, none of which are sufficiently plausible to justify his assertion, unless supported by other facts of which he has made no mention. For instance, though the increased price of oysters may be, as he states, an indication of a diminished supply, yet an increase of the demand would have the same effect. Similarly with regard to the laws relating to the use of dredges and scrapes: the beds might be in their normal state, yet the increased demand or knowledge of the inhabitants of the fore-shores might call for protection of the beds. The action of natural enemies and of natural causes, also mentioned in the article in question, may be neglected. Such causes existed in the past as well as in the present, and yet the beds increased and multiplied as they have done nowhere else in the world.

"But the primary cause of the threatened destruction of this industry," says the author of Lippincott's article, "is the failure to cultivate the oyster." It would have been better had he said "the failure to protect the oyster-beds." Oyster-culture is one thing, no doubt an admirable one, but an expensive, laborious undertaking of doubtful financial success. Oyster protection is a matter easily achieved, with but small expenditure of money, and with but little distress to those depending upon the fishery for support.

It is presumable that our author was not aware of the contributions to the literature relating to oysters and oyster-beds, contained in the "Report of the Commissioners of Fisheries of Maryland," for 1880. Had he examined that report, he would have found matter which would more directly have supported his opinion regarding the deterioration of the Southern oyster-beds, and have suggested to him means of restocking the impoverished areas, other than by the expensive and laborious methods detailed in his paper. The tentative steps taken toward the latter end, by successfully propagating the oyster artificially, are detailed by Dr. Brooks, of the Johns Hopkins University, in the above-mentioned report, and the general condition of certain areas covered by oysters are described in extracts from official reports made by myself to the Superintendent of the Coast and Geodetic Survey. It is from those reports, the paper of Dr. Brooks, and the various works relating to oysters and oyster-culture here and abroad, that the material for this report is drawn.

While few will dispute the assertion that the Northern oyster-beds are practically exhausted and have become mere fattening-places for the transplanted Southern oyster, many will dispute the assertion that the beds of Maryland and Virginia are in a nearly similar condition, or

in danger of soon becoming so. It rests with us, then, to determine that question with as much accuracy as possible, and, should we find the evil an existing one, to show the best means of removing it.

First, are the beds of Maryland and Virginia deteriorating?

It is only possible to speak with entire accuracy of a limited portion of the entire area covered by oysters in these States, but, as the influences affecting the beds are very similar, it may be assumed with safety that the condition of the beds of one district will be, approximately, that of all; at least, it is certain that beds or localities presenting like peculiarities will be in a similar condition as regards reproduction. The only locality in this country which has been thoroughly studied lies on the eastern shore of Chesapeake Bay, opposite the mouth of the Potomac River. The investigation was carried on by the Coast and Geodetic Survey during the summers of 1878 and 1879, and included the survey of the beds of Tangier and Pocomoke Sounds, the measurement of the depth of water over the beds, and direction and force of currents; the ascertainment of the character of the bottom, the constituents and specific gravity of the water on both flood and ebb tides; the temperature during the summer months or spawning-season; the effect of gales, ice, and freshets; and of the fishery either with dredges or tongs. In general terms, as elaborate a study of the beds of the locality was made as was possible.

Tangier and Pocomoke Sounds were selected on account of the immense extent of their oyster-beds, and because they permitted the study of all the varying conditions affecting the oysters.

The two sounds are arms of Chesapeake Bay, and lie opposite the mouth of the Potomac River, on the eastern side of the bay. Tangier Sound extends north from Watt's Island, at its entrance, about thirty-six miles, and is separated from the bay by a chain of low, marshy islands; it receives from the eastern peninsula the waters of several creeks and rivers, all of considerable importance. The shoals on each side of the channel are covered with oyster-beds, and, where the beds do not exist, the oysters are scattered either in groups or singly. They are also found as continuations of the beds, or scattered in the straits separating the different islands and joining the waters of the sound to those of the bay. On each side of the channels of the tributaries of the sound oyster-beds are also found, and, generally speaking, it may be said that throughout Tangier, in depths between one and six fathoms, oysters may be taken in varying numbers. The entrance to Tangier Sound is also the entrance to Pocomoke Sound, Watt's Island lying between the two at their confluence. Pocomoke stretches to the northward and eastward, extending into the peninsula, while Tangier lies along its western boundary.

Pocomoke Sound is twelve and a half miles long and about nine miles broad near the middle, decreasing in breadth near the head and entrance. The channel is narrow and tortuous, and the main body

of the sound is shoal, and these shoals covered with oysters scattered singly and in small groups, or existing in large, well-defined beds. Several small creeks empty their waters into this sound, and one large river, the Pocomoke, discharges into it also. The majority of the beds were found on the eastern side of the sound, and the largest were about the middle and near the mouths of the creeks. The beds in both sounds were located and defined during the summer of 1878, and the area upon which oysters were scattered was also ascertained approximately. The entire area in both sounds upon which oysters were found amounts to fifty-four square miles. The area covered by oysters, but only very thinly, they being scattered in small groups or singly, comprises in Tangier Sound fourteen square miles, and in Pocomoke Sound twenty-nine square miles. The area of the beds proper, or those grounds where the oysters are to a great extent uniformly spread and where the majority of the dredging-vessels work, amounts to six square miles in Tangier Sound and to four square miles in Pocomoke Sound.

The information obtained in 1878, so far as it related to the condition of the beds, may be summarized as follows: The number of oysters on the beds had been very much diminished since the commencement of the fishery, or during the last thirty years. The area of the beds had been greatly increased since the commencement of the fishery. There had been during the period alluded to no change of the usual natural conditions to which the animals are subjected.

Before attempting to draw any conclusions from the above, it will be well to see if the extension in area of the beds and diminution of the number of oysters can be accounted for by the action of natural, unassisted causes.

After the original formation and growth of the beds, they would at some time, the same conditions continuing to operate, cease their development, neither increasing in size nor in number of oysters, there being a natural limit to expansion in either direction. Suppose, then, a bed to have extended itself as far as the conditions of bottom and water or other natural limit would allow, all future expansion could be only in the number of oysters on the bed, and this is limited by the amount of food and room for development, the question of enemies not being considered, as, there being no increase, if they were not in sufficient numbers to prevent the growth of the bed and number of oysters, they would not be sufficient to cause its destruction or deterioration. The number of oysters on a limited bed would then steadily increase, as long as there were sufficient room and food supplied them, until they had reached their limit, a rather undefinable one, in that direction. Having reached that point, the number of oysters would to all intents remain the same as long as the conditions under which they had previously lived were not changed. To cause, then, either an increase or diminution of the number of oysters or the size of the

bed, a new factor must be brought into operation, when, all conditions being changed, the life of the animals begins anew and progresses differently.

As already stated, the character of both beds and oysters in the locality under consideration has undergone great changes during the last thirty years, and the causes for those changes must be sought among such as it is known would produce like effects. Disregarding for the present the agency of man in the matter, the question is, What natural cause or causes would both expand the beds and diminish the number of oysters?

A bed is extended, naturally, by the drifting "spat" or young brood attaching themselves to any appropriate "cultch" contiguous to the bed. This manner of extending the area is much assisted by the current, and consequently natural extension is greatest in the direction of the currents. The principal expansion of the beds, so far as could be effected by Nature, must, however, have been accomplished long ago, for as far back as can be remembered the beds have been surrounded by soft bottoms of a character most destructive to the young brood. Unless, then, some substance is interposed between this soft bottom and the drifting "spat," they will sink into it and be destroyed. Nature has no means of offering such a substance except to a very small extent, and consequently the great expansion of the beds could not have been the result of natural causes, but must be assigned to other agents.

The diminution of the number of oysters might have been effected by several natural causes. An increased deposit of earthy or vegetable matter upon the beds would, if in sufficient quantities to bury the oyster, effect the destruction of old and young. No such deposit has been noticed, nor could it well occur without showing its presence in other ways, principally by changing the channels and causing shoals, but no such changes have occurred; the deviations in channels, shoals, and character of bottom, from those established by the first hydrographic survey of the locality, being very slight indeed.

A change in the character of the water and bottom which would probably follow a change of channel, and possibly occur without such change, might, by depriving the animals of their proper food, cause their deterioration and destruction; but such a change, though it would certainly diminish the number of oysters, would do so suddenly, and the evil effects would be noticed in the oysters remaining, their quality, flavor, and vitality being very much impaired. No such impairment has been observed, however, the animals being at present much larger and finer than when the beds were first discovered.

That fact alone will eliminate many quantities from the equation, for any natural cause injurious to all the oysters on a bed would show its effects upon those remaining, and an examination of a few specimens would be sufficient to determine the question. If, however, the

destruction of the mature oysters or the non-production of the young is accomplished by means that are harmful only to those individuals directly affected, a cause for the diminution is discovered in harmony with the existing facts.

Considering first the destruction of young, large numbers, immense when compared with the production of the higher orders of animals, are annually destroyed by the falling of the "spat" upon unfavorable ground, the prevalence of heavy freshets which would drive the brood into the bay and probably cause its loss, the ravages of various enemies, and unusual changes of the temperature and density of the water. But all these causes have been in operation continually since the first discovery of the beds, and the animals have survived and increased while contending with them. Therefore, some increase of power must be assigned to one or all of these causes, in order to account for the diminished number of oysters, and there is no reason to suppose that there has been such increase. Thus, by reviewing all the natural causes which affect the beds, we can assign to none of them the destruction of either young or old oysters, or the extension of the beds which has been coincident with the diminution of the number of animals. Remaining, then, as the only other operating cause, is the agency of man.

The oyster-fishery in these localities is carried on in two ways, either by "tonging" or "dredging." The first method, being confined to small areas and to a limited number of fishermen, and susceptible of use but in shoal water, need not be considered. The second method of taking the oysters is as follows: the implement used is called a dredge, or scrape, and resembles a large iron claw, the nails representing the teeth of the dredge. To the back of this claw, or the dredge, is fastened a bag of iron mesh-work, large enough to hold two or three bushels. When the dredge is dragged along the bottom the teeth or claws dig up the oysters and shells, which pass between them and into the network behind. The action is somewhat like that of a harrow. The dredges vary greatly in size, being from two to five feet across the mouth, and of greater or less weight, according to the depth of water in which it is intended to use them. The dredging-vessels vary in size from five to thirty tons, and all use two dredges. When on the oyster-ground the dredges are dropped one from each side, and a sufficient amount of line paid out to insure the "taking" of the teeth; the vessel is then kept under easy sail and at a moderate speed until the dredges are full, that being indicated by the strain on the dredging-line and by other signs known to the fishermen. The instrument is then hauled in by means of a small winch, the contents emptied on the deck, and the dredge put over again. This is continued until the vessel is near the edge of the bed, when the dredges are recovered, the vessel put about, and the dredging resumed in an opposite course. While the dredges are in the water, the mud, sand, sponge, grass, or other *débris* brought up are separated from the oysters, and,

together with all oysters unfit for market, thrown back into the water. The limits of the dredging-grounds are not accurately defined, and the vessels frequently drag large numbers of shells and oysters some distance beyond the boundary of the beds. The dredge, especially when full, acts as a scrape, and carries before it much that would be collected in the network attached to it, had that receptacle been open. After "culling" the oysters, or separating them from the old shells, those shells are thrown back again and with them many young oysters. Should they fall on suitable ground, and any which is sufficiently consistent to support them is suitable, they form a small colony which, by action of natural causes, or the dredges, soon becomes attached to the main bed and the area of the latter is thus enlarged. The exposure of suitable "cultch" on bottoms contiguous to the bed is effected by the dredges in the above manner, and they are thus mainly instrumental in extending the area, especially by their direct action in raking down the bed and spreading the shells and oysters. Will the dredging also account for the diminution of the oysters?

Without, for the present, going into the question of propagation, which will be subsequently discussed, it may be stated here that both male and female of the American variety of oyster expel the generative matter into the water, where the eggs must meet the male fluid in order to be fertilized. That being the case, it is evident that the more compact the bed, the more closely settled the community of oysters, the greater the chance the ova and spermatozoa have of coming in contact; or the chance of fertilization of the eggs is inversely proportional to the distance separating the oysters. Hence, should the mature, spawn-bearing oysters on any bed become very much diminished in number or widely separated from each other, there would be but a slight chance of contact of ova and spermatozoa, and a consequent failure of reproduction. Should the bed be so situated that the currents passing over it did not also pass over other more plentifully stocked beds, it would receive no outside support, and the mutual assistance generally rendered would not be obtained. This is the case with one of the largest beds in Pocomoke Sound, and, as would be inferred, the most extensive deterioration was noticed on that bed.

The removal of mature brood-oysters would, then, cause a diminished fecundity, and, should this removal continue, the fecundity will naturally diminish, until there is virtually no reproduction on the bed. But the removal of brood-oysters is not the sum total, by any means, of the effects of the dredging. Millions of young oysters, unfit for market, are carried off sticking to the shells of the mature oysters, and with those shells find a final resting-place on the shell-heaps of the packing-houses. Nearly as many young are destroyed by being thrown from the dredging-vessels upon soft or unfavorable bottoms, no care being exercised, in the hurry and press of work, to see that the young are returned to the beds or other suitable ground.

Theoretically, then, the dredging would—1. Extend the beds; 2. Destroy their fecundity by removing the brood-oysters and by destroying their progeny. Practically, has this been the case?

In the absence of previous surveys of the beds, the testimony of the fishermen must be accepted with regard to the extension of area, and the testimony was unanimous to that effect, some of the beds having doubled in size during the last thirty years. The testimony was also to the effect that all the beds in question had materially deteriorated, the general opinion being that, with the improved appliances now in use, there could have been taken twenty-five years ago from two to seven times as many oysters as at present! But we are not compelled to rely solely upon these statements. A comparison of the results obtained from an investigation of newly discovered beds in the Chesapeake Bay with those beds in the sounds that had long been subjected to the dredging influence shows marked differences, and affords more certain methods of proving the deterioration of old beds. In 1879 areas were discovered in the bay upon which oysters existed, and the locality of which was known to but few of the fishermen; the beds were thus practically in a natural state. The following differences were observed between them and the beds in the sounds: On the new beds in the bay the oysters were generally found in clusters of from three or four to twelve and fifteen; the shells were clean and white, and free from worms; the spaces between the larger oysters were filled with the young growth and barnacles; usually the clusters had a large tuft of red sponge attached to them, and sponges were very plentiful over the beds; the mature oysters were long and narrow, with the lower valve very deep and bills very thin and sharp; the animal itself was much larger and thinner than those of the same age on the worked beds in the sounds; and this last difference is probably due to the difference of water and to the fact that, growing as they do in clusters, food is not so readily obtained. The oysters taken from a bed which has been worked for some time are usually single or in clusters of two or three; they are larger than the corresponding class on the unworked beds—that is, broader in comparison to their length and of greater thickness; the valves are blunt and thick about the lips; and the animal fatter and thicker than those of the same age in the new beds. The shells are dirty, with much mud or sand clinging to them. There is but little sponge attached to the shells; but they are covered with worms, and bored in many places by the boring pholad; and the older the bed and oysters, the larger the number of worms and the less healthy is the appearance of the shell.

The new beds were hard, and the clusters seemed more firmly attached to the bottom, and required greater force to detach them than was necessary on the beds in the sounds. There was comparatively but a small number of broken shells, and the bottom was usually too hard to be penetrated by an iron probe. The beds in the sounds were

soft and easily penetrated. The dredge took the oysters readily, and without great effort. There was much mud among the oysters, and the amount of old broken shells and other *débris* was quite large. It is evident that in any community there must be in the life of a given generation a depletion of number in each successive stage of existence, or, in other words, as the age of the generation increases, the number of individuals decreases. Therefore, on an oyster-bed we should have a larger number of young than mature oysters, provided that we include as "young" the offspring of a sufficient number of spawning-seasons to guard against irregular production in any one season; and, if, having taken that precaution, we find the number of mature oysters to exceed the number of young growth, we may safely decide that there is a deficient production due to some cause, natural or otherwise.

On a natural bed which has not been worked, and which has had no abnormal conditions to contend with, the number of young oysters should, then, exceed the number of those mature. Let us see if this was actually the case on the unworked beds in Chesapeake Bay.

All the oysters examined during the season of 1879 were measured and distributed into four classes. The first two classes comprised the mature oysters; the last two, the young growth. During the season several areas which had never been dredged over were carefully examined, with the following result: Over twenty thousand oysters were measured and classified, and the ratio of young growth to mature oysters was found to be as three to two, or one and five tenths of the former class to one of the latter. This ratio was accepted as a standard, and the ratios of young oysters to mature on all the beds in the sounds were compared with it separately and collectively. Over one hundred thousand oysters were taken from those beds, measured and classified in a similar manner to that adopted for the oysters from the beds in the bay, and the ratio of young growth to mature oysters was found to be as three to six, or five tenths of the former class to one of the latter. Thus, on the new beds the young growth outnumbered the mature, while on the worked beds in the sounds the mature oysters outnumbered the young growth.

The action of the dredge is very destructive to the oysters remaining on the bed. They are not only roughly detached from each other and from the different objects to which they cling, but are, no doubt, frequently left in such positions as will prevent the opening of the valves without allowing the entrance of mud or sand, and thus insuring destruction. The teeth of the dredge also break the lips of the valves, and thus prevent their complete closure, which is the only defense of the oyster against its numerous enemies. Thus, the dredge causes the destruction indirectly of a large number of oysters that remain after its passage, and hence the number of old empty shells should be greater upon a bed that has been dredged than upon one

that has not; and, if that number is very large, it shows that the population of the bed has been destroyed. Upon an unworked bed the number of old shells will show approximately the number of oysters perishing from natural causes; and, should the number on any worked bed exceed this on the undredged one, it may be concluded that Nature is being assisted in her work of destruction.

The quantity of matter brought up in the dredge was measured in all cases during the season of 1879, as was also the quantity of oysters and of *débris*. On the unworked beds in the bay this *débris* was found to equal thirty per cent. of the whole amount of matter brought up. On nearly every bed in the sounds the percentage of *débris* was greater than that on the unworked beds, and in Pocomoke Sound it was extraordinarily large, amounting in some of the beds to as much as ninety-seven per cent.!

During the season of 1878 a method was devised by which the number of oysters to the square yard could be determined approximately; and, though this number was not near the true one, yet, as the measurements were always made in the same manner, it was useful as affording a standard for comparing the results of subsequent seasons or of different localities.

The number of oysters to the square yard obtained by this method depended mainly upon the number of oysters brought up by the dredge; and, as already explained, the difficulty of obtaining the animals was much greater on the new and unworked beds than upon those which had been dredged for many years; therefore, the number to the square yard, other things being equal, should be much greater on the old beds than upon those recently discovered. To make this plainer, a very simple illustration will suffice: Any person knows that the plowing or harrowing of a field frequently subjected to that process is much easier than the breaking up of entirely new ground, and the dredging of an oyster-bed is very similar to the harrowing of a field.

The number of oysters to the square yard, as shown by the method used, should then be greater upon the old beds than upon the new, and, comparing the results of successive seasons on the same bed, if it is found that the number of oysters to the square yard is decreasing, it may be concluded that too large a number of the animals is annually removed. The investigation of the beds in 1879 showed that on sixty per cent. of the beds in Tangier Sound there was a decrease in the number of oysters during the season of 1878–'79, and that on sixty per cent. of the beds the number of oysters to the square yard was *less* than on the newly discovered beds in the bay, and in no case was the number much greater. In Pocomoke Sound, *on every bed* the number of oysters to the square yard was *considerably less* than in 1878, and also *much below* the number on the new beds in the bay.

On several of the beds in the sounds the ratio of young growth to

mature oysters was found to be considerably larger than that on the unworked beds, and there was thus, apparently, a much increased production upon the former areas, or the ratio apparently indicated that, instead of deteriorating, the beds were improving, though all other indications were the reverse.

It is evident that, if the number of young growth falls below the number of mature oysters, the fecundity of the bed is impaired; but it does not follow that, if the young greatly outnumber the mature, it is a sign of increased production, for, though the ratio may be increased by increasing the antecedent, or the number of young, it may also be increased by diminishing the consequent, or number of mature oysters. We know that from the beds in question many millions of oysters are annually removed, and that a large percentage of them are mature; and, if this removal of one class is excessive, it might show itself in the increased ratio of young oysters to mature. Supposing this to be the case, the young would then greatly outnumber the mature for about three years, or the period necessary to pass from youth to maturity. During this period there is a constant removal of the brood-oysters, and, as the reproduction depends upon them principally, the number of young spawned during that period will constantly decrease, so that at the end of three years the mature oysters would probably outnumber the young, and the ratio be as abnormally small as it was abnormally large. Now, with the large number of mature oysters there would be an increased production, and at the end of the second period of three years the ratio would again change, and in this way will increase and diminish alternately, while the number of oysters will constantly diminish. In time, however, the brood-oysters will become so scarce and so widely separated that the fertilization of the eggs will be more and more improbable, and the young will consequently remain in the minority, and, the fishing continuing, the entire destruction of the breeding power will be but a matter of time.

During both seasons of the investigation of the question here discussed, every effort was made to collect statistics of the oyster-fishery, and from these statistics has been estimated the number of oysters removed in a day and in the season. In 1878 this number was over 1,500,000 per day; in 1879, over 700,000 per day. In the sounds the dredging continues throughout the year, though comparatively little is done during the summer months. As the law sanctions the working of the beds only from October 1st until May 1st, in order that any error may be in under- rather than in over-estimation, I will consider the dredging to be confined to that period, and will make the very liberal allowance of three days in each week for bad weather which would prevent work. The dredging-season would then be one of one hundred and twenty days, and in that time there would be removed from the beds, by the estimate of 1878, over

184,000,000 oysters; and by the estimate of 1879, over 89,000,000 oysters. The number of young growth removed would be, by the first estimate, 148,000,000; by the second, 36,000,000. The statistics collected in 1879, when compared with those collected in 1878, show that there were twice as many vessels at work in 1878 as in 1879, which accounts to a great extent for the difference of 95,000,000 mature oysters, as shown by the estimates for each season. The difference in the yield of young growth is due to the fact that, owing to the variations in temperature during the spawning-season, the summer of 1879 was a bad one for the "spat," and consequently there was a failure of "young."

So far as can be at present ascertained, the mortality among the young after attachment is about fifty per cent., and consequently only about 74,400,000 of the young removed in 1878–'79 would have attained an age of one year, and perhaps the number would not reach even that figure. If none of the oysters had been removed from the beds during the dredging-season of 1878–'79, we would have had, when the last season's investigation was in progress, about 259,000,000 more oysters on the beds than was actually the case, and of that number seventy-one per cent. were mature and spawn-bearing. Now, as sixty-five per cent. of those in the beds are mature, the addition of the 250,000,000 would increase the percentage to sixty-eight, or the young growth would be in a more hopeless minority than before.

To prove more conclusively the effect of the fishery upon the ratio of young to mature oysters, I will take as examples the condition of two of the largest beds in Tangier Sound, where the number of young growth was much in excess of the number of mature oysters. The beds are known as the "Great Rock" and "Woman's Marsh." On the former the ratio of young growth to mature oysters was as three to one, or twenty-four per cent. were mature; on the latter the ratio was as one and seventy-four hundredths to one, or thirty-six per cent. were mature. By consulting the statistics collected, I find that of the oysters removed from the Great Rock in one year, sixty-four per cent. were mature, and of those removed from the Woman's Marsh sixty-nine per cent. were of the same class. If these oysters had not been removed, we would have on the Great Rock forty-four per cent. of the community mature, or the ratio of young growth to mature oysters would be as one and one tenth to one; and on the Woman's Marsh the percentage would be fifty-two instead of thirty-six, and the ratio would be as nine tenths to one. It is evident from the foregoing that a very large ratio of young growth to mature oysters is not an indication of an increased production, but, as explained, is due to the removal of too large a number of brood-oysters.

We have, then, three indications of the deterioration of the beds: the number of young is either much smaller or larger than the number

of mature oysters, and in the latter case it is so large as to be abnormal; the amount of *débris* found on the beds is much greater than in the newly discovered areas; and the number of oysters to the square yard not only falls below what it should be, but has decreased since the first examination in 1878. The testimony of all persons living in the vicinity of the sounds is to the effect that there has been a marked deterioration of the beds since they were first discovered and worked, and it is the general opinion that, had the improved implements and appliances now used in the fishery been available when the beds were first discovered, from three to five times as many oysters as are taken at present could have been obtained in Tangier Sound, and about seven times as many in Pocomoke Sound; that even with the insufficient implements then in use more oysters were taken, *per sail*, in the same time than was possible at present.

Considering this testimony, and the results of the comparison of the worked beds in the sound with the unworked ones in the bay, it may be concluded that the former areas are much impaired in productive power, and, the same causes continuing to operate, there will be a constant deterioration until that productive power is entirely destroyed. As there is no indication of any natural cause influencing the beds in the sounds and not the contiguous ones in the bay, we are compelled to assign, as the cause for the deterioration and impaired fecundity of the beds in Tangier and Pocomoke Sounds, the excessive and exhaustive fishery peculiar to them, and from which the beds in the bay have heretofore been free.

The fishery in the sounds is not more extensive than it is in many other localities in Chesapeake Bay: the conditions under which the beds exist are nearly the same; the laws governing the fishery are the same; and about the same amount of attention is paid to them. It is probable, then, that were the remaining beds of the Chesapeake examined carefully, they would present indications of deterioration similar to those shown by the Tangier and Pocomoke beds.* That this deterioration is due to the severe fishing can not be doubted. That in time it will amount to utter exhaustion is a fact well known to those who have given any attention to the matter. To those who have not, the following information may be interesting. Only a few of many cases are cited, but enough, it is hoped, to show that the experience is not confined to small areas or one country; that one result follows invariably upon the heels of over-fishing, and that result is, exhaustion.

The records of the production of the beds of Cancale Bay, on the northwest coast of France, which extend over a period of sixty-eight years, from 1800 to 1868, are perhaps the most instructive:

The beds in the bay comprise an area of about one hundred and fifty acres, and, from 1800 to 1816, produced annually from 400,000 to

* Recent investigations by the Coast and Geodetic Survey confirm this opinion.

2,000,000 oysters. This, however, was the period of the Napoleonic wars, and the fishery was much disturbed by the English cruisers. During this time the beds became so thickly stocked that the oysters were in some places a yard thick. After the close of the war the fishery improved, and the oysters were removed in larger and increasing numbers until 1843.

From 1823 to 1848 it is supposed that the dredgers were living upon the animals accumulated during the period of enforced rest, from 1800 to 1816. In 1817 the number of oysters produced was 5,600,000, and until 1843 there was a constant increase, the number taken in that year being 70,000,000. In 1848 it was 60,000,000, and thenceforward there was a constant decrease. From 1850 to 1856 the decrease was from 50,000,000 to 18,000,000, and was supposed to be the effect of over-dredging. From 1859 to 1868 the decrease was from 16,000,000 to 1,079,000, the oysters having almost entirely disappeared from the beds, *though on account of the suffering condition of the inhabitants of the shores* it was impossible to prevent it or restrict the fishery. In 1870 there was a *complete wreck of the bottom*, which could only be remedied by a total prohibition of the fisheries for several years.

From the beds of the districts of Rochefort, Marennes, and Isle d'Oléron, on the west coast of France, there were taken, in 1853–'54, 10,000,000 oysters; in 1854–'55, 15,000,000. On account of exhaustive fishing, in 1863–'64 only 400,000 could be obtained.

According to Mr. Webber, Mayor of Falmouth, England, about seven hundred men, working three hundred boats, were employed in a profitable oyster-fishery in the neighborhood of Falmouth until 1866, when the old laws enforcing a close-time were repealed, under an impression that, owing to the great productive powers of the oyster, it would be impossible to remove a sufficient number to prevent the restocking of the beds. Since 1866 the beds have become so impoverished, from the excessive and continual fishery, that in 1876 only forty men and less than forty boats could find employment, and, small as that number is, they could not take more than sixty or one hundred oysters a day, while formerly, in the same time, one boat could take from ten to twelve thousand.

According to the statement of Mr. Messum, an oyster-dealer and secretary of an oyster company in Emsworth, England, there were in the harbor of Emsworth, between the years 1840 and 1850, so many oysters that one man in five hours could take from twenty-four to thirty-two thousand. In consequence of over-fishery in 1858, scarcely ten vessels could find loads, and in 1868 a dredger, *in five hours, could not find more than twenty oysters!*

The oyster-fisheries of Jersey, in the English Channel, afforded employment to four hundred vessels. In six or seven years the dredging became so extensive and the beds so exhausted that only three or

four vessels could find employment, and the crews of them had to do additional work on shore in order to support themselves, the returns from the beds being so inadequate.

The evil of excessive fishery then exists, and, continuing, can have but one effect, and we have seen how disastrous is that result. Our oyster-beds are, however, so extensive, the animals are so widely distributed, and are so easily transported and transplanted, that the total failure of the American oyster-beds must be postponed for some time. But the failure of the beds of different localities may occur at any time, and it is more than probable that those of Chesapeake Bay will be practically exhausted before many years. The deterioration and final exhaustion of the beds, either of particular localities or of the whole country, would, however, cause far greater distress, discomfort, and inconvenience in the United States than the failure of the foreign beds caused abroad. With us the oyster is no luxury, but a means of subsistence to a large number of people. Oysters are consumed from Maine to Texas, and from the Atlantic to the Pacific, and immense numbers are also annually exported. In supplying this great demand numbers of the poorer classes of citizens find a constant and profitable employment, and thus the deterioration of the beds, or extinction of the oysters, would not only be felt by the consumer in the much-increased price of a desirable and nutritious article of food, but by the producer, in a loss of employment, and that loss occurring in localities where there is hardly any other resource.

[The natural history of the oyster with especial reference to the process of reproduction and the conditions influencing its rate of increase will form the subject of a concluding article.—Ed.]

## VOLCANOES, THEIR ACTION AND DISTRIBUTION.*

"WHAT is a volcano?" This is a familiar question, often addressed to us in our youth, which "Catechisms of Universal Knowledge" and similar school manuals have taught us to reply to in some such terms as the following: "A volcano is a burning mountain, from the summit of which issue smoke and flames." This description, says Professor Judd, is not merely incomplete and inadequate as a whole, but each individual proposition of which it is made up is grossly inadequate and, what is worse, perversely misleading. In the first place, the action which takes place at volcanoes is not "burning," or combustion, and bears, indeed, no relation whatever to that well-known

* Volcanoes, what they Are, and what they Teach. By John W. Judd, F. R. S. With Ninety-six Illustrations. "International Scientific Series." In press of D. Appleton & Co.

process. Nor are volcanoes necessarily "mountains" at all; essentially, they are just the reverse—namely, holes in the earth's crust, or outer portion, by means of which a communication is kept up between the surface and the interior of our globe. When mountains do exist at centers of volcanic activity, they are simply the heaps of materials thrown out of these holes, and must, therefore, be regarded not as the causes but as the consequences of volcanic action. Neither does this action always take place at the "summits" of volcanic mountains when such exist, for eruptions occur quite as frequently on their sides or at their base. That, too, which popular fancy regards as "smoke" is really condensing steam or watery vapor, and the supposed raging "flames" are nothing more than the glowing light of a mass of molten material reflected from these vapor-clouds. The name of volcano has been borrowed from the mountain Vulcano, in the Lipari Islands, where the ancients believed that Hephæstus, or Vulcan, had his forge. Volcanic phenomena have been at all times regarded with a superstitious awe, which has resulted in the generation of such myths as the one just mentioned, or of that in which Etna was said to have been formed by the mountains under which an angry god had buried the rebellious Typhon. These stories changed their form, but not their essence, under a Christian dispensation, and Vulcano became regarded as the place of punishment of the Arian Emperor Theodosius, and Etna as that of Anne Boleyn, who had sinned by perverting the faith of King Henry VIII.

Volcanic phenomena can be studied to great advantage in Stromboli, whose crater, the edge of which is easily accessible, is in a state of constant moderate action, and can be watched for hours together without having the judgment warped either by an excited imagination or the sense of danger. It is an island of rudely circular outline and conical form, and rises to the height of three thousand and ninety feet above the level of the Mediterranean (Fig. 1). From a point on the side of the mountain masses of vapor are seen to issue, which unite to form a cloud over the summit, the outline of which varies continually according to the hygrometric state of the atmosphere and the direction and force of the wind. At the time the sketch was made, April 20, 1874, the vapor-cloud was spread in a great horizontal stratum overshadowing the whole island, but was clearly seen to be made up of a number of globular masses, each of which was a product of a distinct outburst of the volcanic forces.

The mountain is visible over the sea for a hundred miles. When it is watched from the deck of a vessel anywhere within this distance, "a glow of red light is seen to make its appearance from time to time above the summit of the mountain; this glow of light may be observed to increase gradually in intensity, and then as gradually to die away. After a short interval the same appearances are repeated, and this goes on till the increasing light of the dawn causes the phenome-

non to be no longer visible. The resemblance presented by Stromboli to a 'flashing-light' on a most gigantic scale is very striking, and the mountain has long been known as the 'lighthouse of the Mediterranean.'"

The island appears, if we land upon it, to be entirely built up of such materials as we know to be ejected from volcanoes; "indeed, it

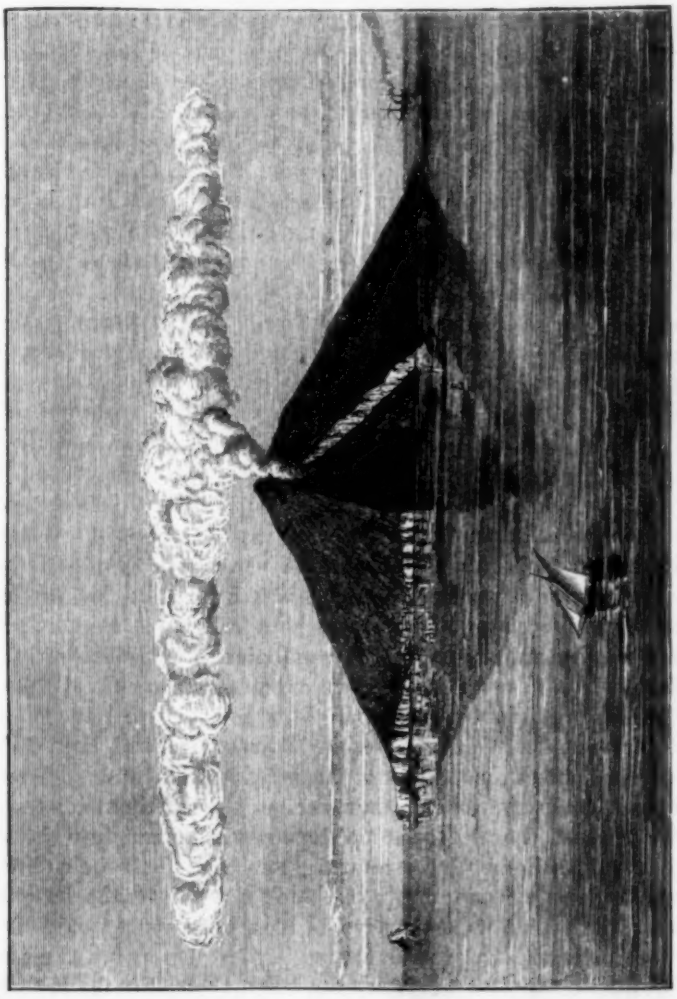

FIG. 1.—STROMBOLI, VIEWED FROM THE NORTHWEST, APRIL, 1874.

resembles, on a gigantic scale, the surroundings of an iron-furnace, with its heaps of cinders and masses of slag. The irregularity in the form of the island is at once seen to be due to the action of the wind, the rain, and the waves of the surrounding sea, which have removed the loose, cindery materials at some points, and left the hard, slaggy masses standing up prominently at others." This pile stands in a sea

of about six hundred fathoms depth; as it rises to more than three thousand feet above the surface, it represents a conical mass of cinders and slaggy materials, six thousand feet high and more than four miles in diameter at the base. The crater may be approached by a flat slope called the Sciarra, which rises at an angle of 35° with the horizon, and ends abruptly at its edge. The accompanying sketch (Fig. 2) was

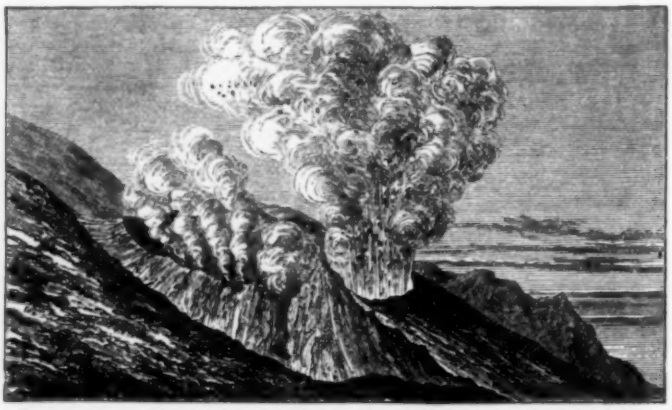

FIG. 2.—THE CRATER OF STROMBOLI AS VIEWED FROM THE SIDE OF THE SCIARRA DURING AN ERUPTION ON THE MORNING OF APRIL 24, 1874.

made from this point at the moment of an outburst. "Before the outburst, numerous light, curling wreaths of vapor were seen ascending from fissures on the sides and bottom of the crater. Suddenly, and without the slightest warning, a sound was heard like that produced when a locomotive blows off its steam at a railway-station; a great volume of watery vapor was at the same time thrown violently into the atmosphere, and with it there were hurled upward a number of dark fragments, which rose to the height of four or five hundred feet above the crater, describing curves in their course, and then falling back upon the mountain. Most of these fragments tumbled into the crater with a loud, rattling noise, but some of them fell outside the crater, and a few rolled down the steep slope of the Sciarra into the sea."

Spallanzani and other later investigators carried on their observations from a point whence they could look down into the bottom of the crater, and, with a wind that would blow the vapors away, sit and watch for hours the wonderful scene. From this point, the black, slaggy bottom of the crater is seen to be traversed by many fissures or cracks, from most of which curling jets of vapor issue quietly and gradually mingle with and disappear in the atmosphere. Besides, there are several larger openings, varying in number and position at different periods, from some of which "steam is emitted with loud, snorting puffs, like those produced by a locomotive-engine, but far less regular and rhythmical in their succession"; from others, masses of

molten material well out and sometimes flow outside of the crater, with steam escaping, often in considerable quantities ; in some a viscid or semi-liquid substance is seen seething, swelling up and forming gigantic bubbles, which burst under occasional great rushes of steam, carrying fragments of the scum-like surface of the liquid high up into the atmosphere, almost precisely as takes place in a pot of boiling mush. At night, "the smaller cracks and larger openings glow with a ruddy light. Every time a bubble bursts, and the crust is broken up by the escape of steam, a fresh, glowing surface of the incandescent material is exposed. If at these moments we look up at the vapor-cloud covering the mountain, we shall at once understand the cause of the singular appearances presented by Stromboli when viewed from a distance at night ; for the great masses of vapor are seen to be lit up with a vivid, ruddy glow, like that produced when an engine-driver opens the door of the furnace and illuminates the stream of vapor issuing from the funnel of his locomotive."

These phenomena differ only in degree from those presented by volcanoes which, like Vesuvius, are spasmodically more active. Occasionally, the violence of the outbursts at Stromboli is temporarily increased ; and at Vesuvius a series of small explosions, quite similar to those occurring at Stromboli, were observed for some months before the great eruption of 1872. French geologists, in fact, define the conditions of activity of volcanoes by speaking of the "Strombolian" and the "Vesuvian" stage as two degrees between which the passage is by insensible gradations. The eruption of 1872, of which the accompanying view (Fig. 3) is from a photograph, afforded a fine example of the intense Vesuvian stage. The activity of the forces at work within the mountain had been on the increase for more than a year, and reached its climax on the day the photograph was taken. During the eruption the bottom of the crater was entirely broken up, and the sides of the mountain were rent by fissures in all directions whence liquid matter appeared to be oozing as from every part of the surface, or as Professor Palmieri expressed it, "Vesuvius sweated fire." Enormous volumes of steam rushed out from the crater and from some of the fissures, to the height, as shown by the picture, of twenty thousand feet, or nearly four miles, with a prodigious roaring sound that frightened the inhabitants of Naples into leaving their houses and seeking refuge in the streets. The roaring was produced by explosions or detonations rapidly following one another, each of which sent up a globe of white vapor, out of a mass of which globes the overhanging cloud was formed. Lava, or molten rock, rushed down the sides of the mountain in great streams, whence enormous volumes of steam continually rose, forcing the congealing rock as it escaped from it into great bubbles and blisters, thus giving rise to the formation of innumerable miniature volcanoes.

Other phenomena accompanying this eruption were the prevalence

of earthquake-shocks in the country around, the vivid lightnings and thunders arising from the electrical action engendered by the column of steam, and the excessive rainfall which followed the condensation of the steam.

In both these volcanoes the active cause of all the phenomena exhibited is found to be the escape of steam from the midst of masses

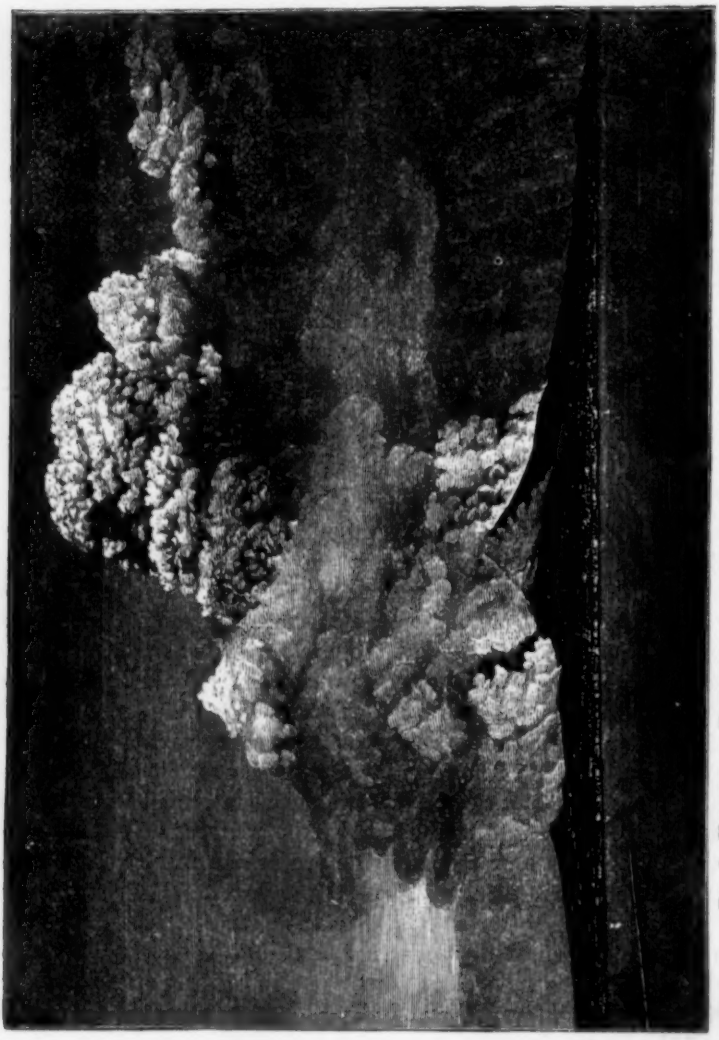

FIG. 3.—VESUVIUS IN ERUPTION, AS SEEN FROM NAPLES, APRIL 26, 1872. (From a Photograph.)

of incandescent liquefied rock. The violence, the grandeur, and the destructive effects of an eruption depend upon the abundance and tension of this escaping steam.

The manner in which volcanic cones are built up is ascertained

from the examination of sections of them. This was first attempted at the suggestion of Goethe, in the case of the Kammerbühl, a small hill in Bohemia, concerning which it was disputed whether its materials had been derived from the combustion of coal or from aqueous precipitation, or whether they were of volcanic origin. An excavation to the core of the hill, finished in 1837, showed that the center of the mass was filled with a plug of basalt, which was connected with a small lava-stream flowing down the side of the hill; while the bulk of the hill was composed of volcanic scoriæ and lapilli (Fig. 4). Nat-

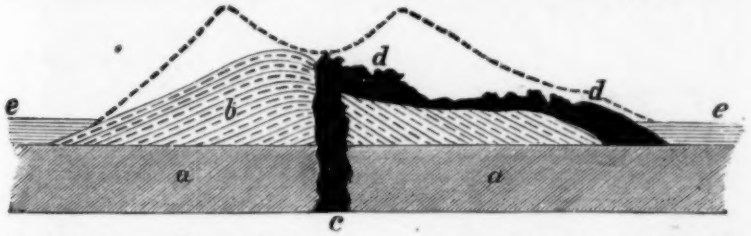


FIG. 4.—SECTION OF THE KAMMERBÜHL, IN BOHEMIA. *a a*, metamorphic rocks; *b*, basaltic scoriæ; *c*, solid plug of basalt rising through the center of the volcanic pile; *d d*, lava-stream composed of the same rock; *e e*, alluvial matter surrounding the old volcano. (The dotted lines indicate the probable former outline of the volcano.)

ural sections are not rare. A very fine one is afforded by the peninsula of Vulcanello, in the Island of Vulcano (Fig. 5). The peninsula consists of three volcanic cones, united at their base, with the lava-

FIG. 5.—VIEW OF VULCANO, WITH VULCANELLO IN THE FOREGROUND, TAKEN FROM THE SOUTH END OF THE ISLAND OF LIPARI.

streams which have flowed from them. One half the cone on the left side of the picture has been completely washed away by the sea, so that a perfect section of the internal structure is exposed, as in the accompanying figure (Fig. 6). This section shows—1. The loose scoriæ and lapilli, *d*, which, in falling through the air, have arranged themselves in tolerably regular layers on the sides of the cone; 2. Lava-

streams, *b*, which have been ejected from the crater or from fissures, and flowed down the sides of the cone; and, 3. Masses of lava, *c*, filling up cracks in the cone, called "dikes." Most volcanic mountains are built up of these three kinds of material, but with varying arrangement and proportions. One kind very often predominates

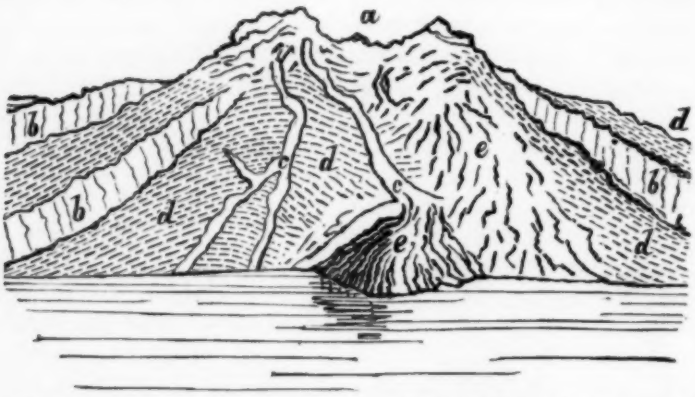


FIG. 6.—NATURAL SECTION OF A VOLCANIC CONE IN THE ISLAND OF VULCANÒ. *a*, crater; *b b*, lava-streams; *c*, dikes which have clearly formed the ducts, through which the lava has risen to the crater; *d d*, stratified volcanic scoriæ; *e*, talus of fallen materials.

almost to the exclusion of the others. The materials falling through the air upon the surface of the mountain assume a stratified arrangement, in which the finer matters are sorted out and carried to a greater distance than the others, the same as when the deposit is made from water. When materials of a different character are thrown out by different eruptions, the distinctions are very plainly marked.

An opportunity was given for observing the formation of a volcanic cone through all its stages in the case of the eruption of Monte Nuovo, or New Mountain, on the shores of the Bay of Naples, in 1538 (Fig.

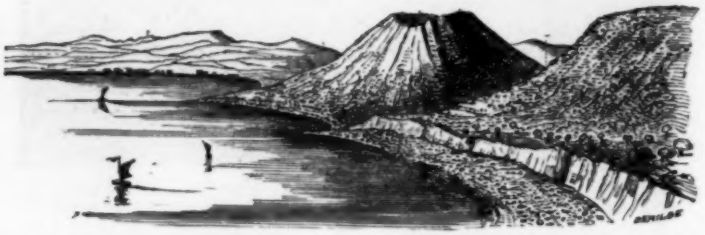

FIG. 7.—MONTE NUOVO (440 FEET HIGH), ON THE SHORES OF THE BAY OF NAPLES.

7). After the neighborhood had been affected by earthquakes for more than two years, on the 29th of September, at eight o'clock in the morning, to be exact, water, first cold, afterward becoming tepid, was observed to issue from a depression which was noticed on the site of the future hill. Four hours afterward the ground was seen to swell

up and open, forming a gaping fissure, within which incandescent matter was visible. Masses of stone and vast quantities of pumice and mud were then thrown up to a great height for two days and nights, and, falling on the sides of the vent, formed a great mound, which was climbed up by adventurous persons on the third day, a quiet one. The ejections were resumed on the next day, when several persons who undertook to climb the hill were killed or injured, but ceased on the seventh or eighth day. The mass of the hill, which is four hundred and forty feet above the sea, was chiefly composed of the materials which were thrown out during the first two days and nights. It consists of scoriæ, lapilli, and dust, and is now covered with a thick growth of pines. The crater is marked by a steep, cup-shaped depression, the bottom of which is but little above the level of the sea. The district in which this mountain is situated contains a great number of hills, strikingly resembling it, some of which are larger, some smaller than it, but all so similar that "no stranger visiting the district, without previous information on the subject, would suspect the fact that, while all the other hills of the district have existed from time immemorial, and are constantly mentioned in the works of Greek and Roman writers, this particular hill of Monte Nuovo came into existence less than three hundred and fifty years ago."

The form of the cones is modified by the character of the materials thrown out, by the action of the weather, and by repeated eruptions. Loose material, scoriæ and lapilli, roll till they reach a position of rest, and leave a more or less regular cone. Very liquid lavas flow to great distances, resting at a very slight slope, as in the volcanoes of Hawaii, where, with a slope of only six or eight degrees, the mountains have a diameter of seventy miles at their base, and reach a height of

FIG. 8.—OUTLINES OF LAVA-CONES. 1. Mauna Loa, in Hawaii, composed of fluid lava; 2. The Schlossberg of Teplitz, Bohemia, composed of very imperfectly fluid or viscid lava.

fourteen thousand feet. If, on the other hand, the lava is only imperfectly liquid, it tends to accumulate around the vent and form a more or less steep-sided bulbous mass, as in number two of the figure (Fig. 8). The shape of the cone may undergo changes during an eruption, as in the accompanying outlines of Vesuvius (Fig. 9). Most of the great volcanic mountains belong to the class of "composite cones," and are built

up by alternate ejections of fluid lava and fragmentary materials. The slopes of their sides are subject to a wide range of variation, corresponding with the varying character and degree of liquidity of these materials. The sides of the cones are liable to be rent asunder and traversed with fissures, through which liquid lava forces its way and

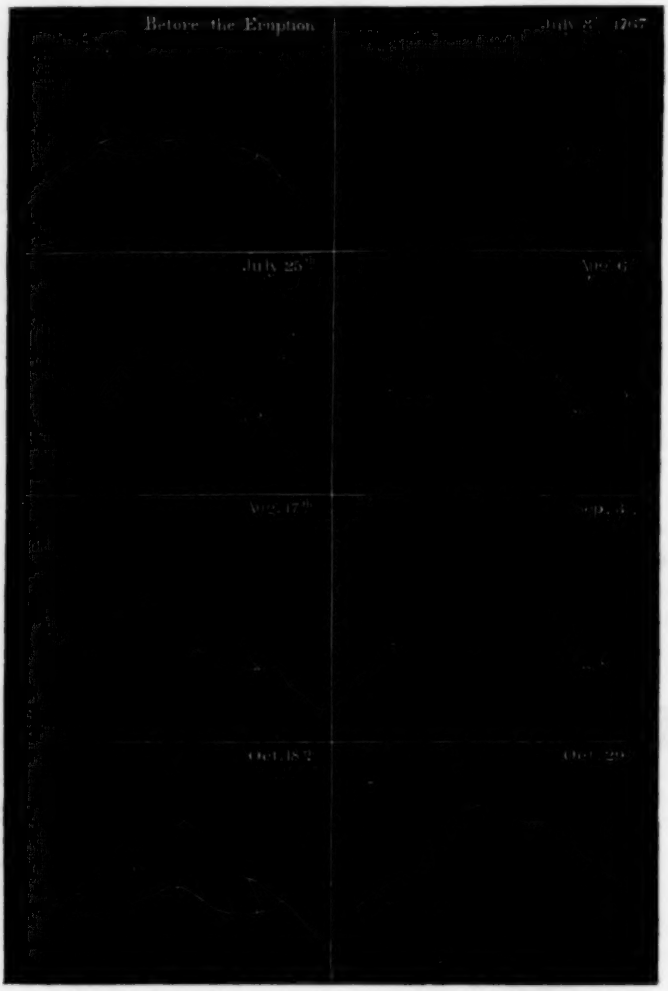


FIG. 9.—OUTLINES OF THE SUMMIT OF VESUVIUS DURING THE ERUPTION OF 1767.

gives rise to new subsidiary cones, or series of cones, along the lines of the clefts. These cones are called parasitic cones, and frequently attain considerable dimensions, some of those on the flanks of Etna being nearly eight hundred feet high. A typical example of a group of such cones is given in the Island of Ischia, where several parasitic

cones have been formed around the main cone. Another example is furnished on the slopes of Etna, where the scoria-cones raised in 1865 along a fissure were so close together as to make a long, irregular ridge (Fig. 10). Seven of these cones were formed along this fissure,

FIG. 10.—FISSURE FORMED ON THE FLANKS OF ETNA DURING THE ERUPTION OF 1865. *a*, Monte Frumento, an old parasitic cone; *b*, line of fissure; *c c c*, new scoria-cones thrown up on the line of fissure; *d*, lava from the same.

thirty-six along another fissure during the eruption of 1874. Similar phenomena were witnessed upon the slopes of Vesuvius in 1760, when a fissure opened on the south side of the mountain, and fifteen scoria-cones, which are still visible, were thrown up along it.

The center of eruption has sometimes shifted itself along a line of fissure, as has taken place at Etna, where the present center is four miles from the old one, and in the Island of Vulcano with the peninsula of Vulcanello, which affords the best possible example of such a shifting. Whole systems of volcanoes appear to be built up along the lines of such fissures, as is shown by the linear arrangement of volcanoes in different parts of the earth, and strikingly in the Lipari Islands, where the volcanoes are arranged along a series of lines which doubtless mark rents in the earth's crust, and which radiate from a center at which we have proofs of the former existence of a volcano of enormous dimensions.

There is also good ground for believing that the great linear bands of volcanoes which, as we shall see, stretch for thousands of miles over the earth, have had their positions determined by great lines of fissure in the earth's crust. While, however, the smaller fissures, upon which rows of scoria-cones are thrown up, seem to have been in many cases opened by a single effort of the volcanic forces, the enormous fissures which traverse so large a portion of the surface of the globe are doubtless the result of numerous manifestations of energy extending over vast periods of time.

It is very hard accurately to estimate the number of volcanoes in the world. They vary in size from immense mountains like Chimborazo and Cotopaxi to mere holes in the ground, letting escape barely perceptible columns of vapor. The history of a large proportion of them has been known only for a brief period, and many which are considered extinct because they have never been seen in action may be merely dormant, ready to burst out at any time, as Vesuvius did in

the year 79. If we include only habitual vents of considerable importance, which we have reason to believe may still be in active condition, the number may be put at between three hundred and three hundred and fifty. Most of these are marked by more or less considerable mountains formed of the matters ejected from them. If we include the mountains which exhibit the main features of volcanoes, but concerning the activity of which we have no record or tradition, the number will not fall much short of one thousand. Then there are other "ruined volcanoes," the cones of which have been worn away and of which the "ground-plans" only are left, still more numerous. The smaller temporary openings, usually subordinate to the habitual vents, known to ancient and modern history and tradition, may be counted by thousands and tens of thousands. The still feebler manifestations—steam-jets, geysers, thermal and mineral waters, fumaroles, mud-volcanoes, and the like—must be numbered by millions. The latter class seem to play a small part as we contemplate them singly, but their force in the aggregate probably far exceeds that of all the great habitual vents. These volcanoes, in all their classes, are very unequally distributed over the globe. Vesuvius is the only habitual vent on the Continent of Europe, and it is on the shores of the Mediterranean; the Mediterranean islands contain six; Africa has ten—four on the western, six on the eastern coast; Asia, so far as is known, twenty-four, twelve of which are on the peninsula of Kamtchatka. None are known in Australia. North America has twenty volcanoes, Central America twenty-five, and South America thirty-seven. In all, one hundred and seventeen volcanoes are situated on the great continental lands, leaving nearly twice that number distributed over the islands of the oceans.

In nearly all cases, the volcanoes are either close to the shores of the continent or at no very great distance from them. The only known exceptions are in the Central Asian plateau and Chinese Mantchooria, concerning which more accurate information is needed. All the oceanic islands that are not coral reefs are of volcanic origin, and many of them contain active volcanoes. A ridge running through the midst of the Atlantic Ocean and embracing the Islands of Jan Mayen, Iceland, the Azores, Canaries, and West Indies, contains forty active volcanoes and a greater number of extinct ones. A similar line in the Pacific Ocean, including the group of islands southeast of the Asiatic Continent, "the grandest focus of volcanic activity on the globe," contains no less than one hundred and fifty active volcanoes; and, if we include those on lines branching from the main one, half the habitually active vents of the globe. A third series of volcanoes starts from near the last one in the neighborhood of Behring Strait, and stretches along the whole western coast of the American Continent, with about eighty active vents.

The volcanoes of the globe thus usually assume a linear arrange-

ment, and are nearly all situated along three well-marked bands and the branches proceeding from them. The volcanoes of the eastern coast of Africa, with Mauritius, Bourbon, Rodriguez, and the vents along the line of the Red Sea, may be regarded as forming a fourth and subordinate band. Nearly all of them are situated near the limits which separate the great land and water masses of the globe, either on the parts of continents not far removed from their coast-lines, or on islands in the ocean not very distant from the shores. Two conspicuous exceptions to this rule are the volcanoes of the Thian-Shan range in Asia, in the center of the largest unbroken land-mass of the globe; and the group of the Sandwich Islands, almost in the center of the largest ocean, and rising almost from the greatest depths of that ocean. Geological researches have, however, shown that the Thian-Shan Mountains in Pliocene times stood on the southern borders of a great inland sea. A regular parallelism seems to exist between volcanic bands and the great mountain-chains; and the researches of Mr. Darwin have shown that "nearly all the active volcanoes are situated upon rising areas, and that volcanic phenomena are conspicuously absent from those parts of the earth's crust which can be proved at the present day to be undergoing depression."

Inferences are sometimes hastily drawn from the fact that most volcanoes are near the ocean which the facts themselves will hardly warrant. Thus, it is frequently assumed that we may refer all the phenomena of volcanic action to the penetration of sea-water to a mass of incandescent lava in the earth's crust and to the chemical and mechanical actions which result from the meeting. This argument, however, as Mr. Scrope has shown, involves a reasoning in a circle. "It is assumed, on the one hand, that the heaving subterranean movements which give rise to the fissures by which steam and other gases escape to the surface are the result of the passage of water to the heated masses in the earth's crust. But, on the other hand, it is supposed that it is the production of these fissures which leads to the influx of waters to the heated materials. If it is the passage of water through these fissures which produces the eruptions, it may be fairly asked, What is it gives rise to the fissures? And if, on the other hand, there exist subterranean forces competent to produce the fissures, may they not also give rise to the eruptions through the openings which they have originated?"

Many of the various theories which have been proposed to account for volcanic action—depending upon the supposed presence of active forces within the earth; upon the contact of water with the hot solid or liquid matter of the interior of the globe; upon the chemical actions that may be taking place within the earth; upon the heat that may be developed by the contraction of the earth's crust; or upon the occlusion of gases by the metallic elements of which many suppose the core of the earth to be composed—have a certain probability. They

are not definitely contradicted by anything that we know, but are as yet still further from being fully sustained by facts; and they all prove to be beset by difficulties when they are subjected to a critical analysis. Thus, "it must be admitted that we do not at present appear to have the means for framing a complete and consistent theory of volcanic action, but we may hopefully look forward to the time when further observation and experiment shall have removed many of the existing difficulties which beset the question, and when by the light of such future researches untenable hypotheses shall be eliminated and the just ones proved and established."

Modern speculation, recognizing that the worlds of our system are bound by the same laws and had the same origin, now tends to look to the study of what is going on in the sun and planets as a valuable aid in ascertaining the reason of the operations to which our planet is and has been subjected.

## PHYSICAL EDUCATION.

By FELIX L. OSWALD, M. D.

### HYGIENIC PRECAUTIONS.

"Dangers we can not avoid we must learn to defy."—LESSING.

CREATURES in a state of nature can almost dispense with sanitary precautions; Providence has secured their safety in that respect. Animals are born with the instinct that enables them to distinguish wholesome from injurious plants. In the wilderness, where the neighborhood of man does not tempt them to brave the winter of the higher latitudes, most birds emigrate in time to avoid its rigors; those that stay can rely on their feather-coats; natural selection has adapted their utmost power of endurance to the possible extremes of the atmospheric vicissitudes. The sexual instinct of wild animals is limited to certain seasons and months that preclude the possibility of their young being born at any but the most favorable time of the year. From birth to death the children of Nature can trust themselves to the guidance of their hereditary inclinations; all the contingencies of their simple lives have been amply provided for.

These provisions do not apply exclusively to a state of affairs which the agency of man has in so many ways modified or even reversed; still, it would seem as if Nature had failed to make adequate allowance for the possibility of certain perils incident to our artificial mode of life. This fact is perhaps most strikingly illustrated by the treacherous *non-repulsiveness* of certain mineral poisons. The offensive taste of poisonous plants seems to be proportioned to the degree of their noxiousness; hemlock, strychnine, and opium are forbiddingly

nauseous, even in the smallest quantities. A drop of prussic acid fills a whole room with its bitter aroma. But arsenious acid is tasteless and odorless, and so unsuspicious to the most wary animals that its name has become a synonym of ratsbane. The reason is apparently this: that Providence (*or* "natural selection") has endowed animals with a protective antipathy against all poisons they could possibly mistake for comestibles, but not against such *out-of-the-way* things as arsenic or sugar of lead, nor against the mixtures by which the art of man has disguised the taste of naturally unpalatable substances. Coffee, without sugar and milk, "straight and strong," as the Turks drink it, would hardly tempt a Christian schoolboy; mixed, it can be made seductive enough to deceive even the *ex-officio* opponents of the stimulant-habit. In such commixtures as milk-punch, beer-soup, "Scutari sherbet," the taste—though not the effect—of alcohol almost disappears; the Algeria trappers catch monkeys with a *mélange* of rum and manna-sirup. A famous cook of the "Frères Provençeaux" used to boast his ability of compounding delightful ragouts from meat in *any* state of decomposition. Early habits and the influence of evil examples also tend to corrupt the integrity of that physical conscience whose arbitrations form the health-code of our dumb fellow-creatures. In large cities the panders of vice vie in the art of making their poisons attractive, and, where such dangers can not be avoided, it is always the safest plan to meet and master them in time.

Early impressions are very enduring, and can make useful habits as well as evil ones a sort of second nature. In order to forestall the chief danger of in-door life, make your children love-sick after fresh air; make them associate the idea of fusty rooms with prison-life, punishment, and sickness. Open a window whenever they complain of headache or nausea; promise them a woodland excursion as a reward of exceptionally good behavior. Save your best sweetmeats for out-door festivals. By the witchery of associated ideas a boy can come to regard the lonely shade-tree as a primary requisite to the enjoyment of a good story-book. "*Or, mes pensées ne voulent jamais aller qu' avec mes jambes,*" says Rousseau ("Only the movement of my feet seems to set my brains a-going"), and it is just as easy to think, debate, rehearse, etc., walking as sitting; the peripatetic philosophers derived their name from their pedestrian proclivities, and the Stoic sect from their master's predilection for an open porch. Children who have been brought up in hygienic homes not rarely "feel as if they were going to be choked" in unventilated rooms, and I would take good care not to cure them of such salutary idiosyncrasies.

Every observant teacher must have noticed the innate hardiness of young boys, their unaffected indifference to wind and weather. They seem to take a delight in braving the extremes of temperature, and, by simply indulging this *penchant* of theirs, children can be made weather-proof to an almost unlimited degree; and in nothing else can

they be more safely trusted to the guidance of their protective instincts. Don't be afraid that an active boy will hurt himself by voluntary exposure, unless his chances for out-door play are so rare as to tempt him to abuse the first opportunity. Weather-proof people are almost sickness-proof; a merry hunting-excursion to the snow-clad highlands will rarely fail to counteract the consequences of repeated surfeits; even girls who have learned to brave the winter storms of our Northwestern prairies will afterward laugh at "draughts" and "raw March winds." Winter is the season of lung-affections, the larger part of them induced by long confinement in a vitiated atmosphere; the part caused by light winter clothes is smaller than most people imagine. I have weathered a good many winters without fur caps and woolen shawls, and I ascribe my immunity to the circumstance that my guardian made it a rule never to force us to wear such things. The Moslems rarely eat before they have washed their hands, and a rather unscrupulous frontier Turk assured me that in his case the practice had nothing to do with superstition; it had become a physiological habit, whose omission, he had found, would produce a fit of very realistic nausea. In the same way more comprehensive ablutions may become a physiological necessity: there are people who owe their sound sleep and other sound things to their inability to go to bed without a sponge-bath. The habit can be formed in one summer.

The dietetic instincts of a rationally educated person should obviate the necessity of special precautions, but in large cities, where temptations walk in disguise, the welfare of inexperienced children may require additional safeguards. In the first chapter of this series I have enumerated the chief arguments of the vegetarian school. Among the incidental advantages of their system it might be mentioned that a purely vegetable diet is the most effectual precaution against a danger which only in one of its exceptional forms was lately brought home to us by the trichina panic. Flesh-eaters always run a risk of inoculating themselves with the germs of the various diseases which both beef- and man-flesh is heir to, consumption especially, and several disorders arising from the corruption of the humors, by the use of decayed or fermented food. Sausage-makers, like trance-mediums, never divulge their trade-secrets, but it is a suggestive fact that, in the Anglo-German cities of this continent, the scrofulous and decrepit old females of the bovine race are known by the name of Bologna cows. Abstinence from *Wurst*, boarding-house hash, and mince-pies, may diminish the danger, but abstinence from all animal food is the safer plan and the easier one. If children were restricted to a vegetable or semi-animal diet (milk, eggs, etc.), I doubt if many of them would afterward choose to overcome that instinctive repugnance to flesh-food expressed in the original meaning of the word *frugality*. The Romans of the Cincinnatian era, though entirely free from Buddhistic scruples, seem

to have eschewed animal food for sanitary reasons. Children with a phthisical taint are certainly better off without it. Give them eggs and all the available vegetable fat they can digest, but no flesh nor milk of anyways doubtful origin. Two or three families of moderate means might rent a bit of pasture-land, and divide the milk of a healthy country cow. The sanitary condition of a single animal could be ascertained by any competent farrier, but the control of a wholesale meat-market will always be more or less perfunctory.

*Principiis obsta* is probably the wisest maxim ever expressed in two words, and I believe that the poison-problem will be ultimately solved on that principle. The work of reform must begin in the nursery ; and, under circumstances where we can not keep temptations from our door, we must make our children temptation-proof, inspire them with an indelible abhorrence of drunkenness and poison-slavery of every kind.

"I still find the Laconic method the shortest," writes a friend of mine, alluding to the Spartan plan of warning boys by the example of a drunken Helot. He used to interest his boy in the *modus operandi* of alcohol, opium, etc., and then take him out, and, under some pretext or other, drop into a slum-saloon on Saturday night, or a police-court on Monday morning, to give him a practical illustration of his theory. Whenever they saw the poison displayed in an attractive form, on ornamental sign-boards or in the gorgeous bottles of druggists and hotel-keepers, they would study the well-baited trap with a peculiar interest, and go their way rejoicing, as in the possession of an invaluable secret. The result was that the boy became "aggressively virtuous," and used to button-hole visitors in order to lecture them on the causes and consequences of the popular delusion.

Even city boys do not often contract the nicotine habit till after their twelfth year, and a fit of tobacco-nausea before that time generally induces a forbidding reaction not easy to outgrow. I remember the case of a brutal tavern-keeper who tried to accustom his son to the fumes of Alsatian leaf-tobacco (*vulgo Stinkewitz*), and the unexpected result of his last experiment. He took the lad on a stage-coach trip from Colmar to Metz, and induced the postillion to take in a few extra passengers, whom he treated to clay pipes and Stinkewitz. He then closed the windows, and in less than twenty minutes his son turned deadly pale, and would have fainted if he had not found relief in a violent fit of retching. If he had loathed Stinkewitz before, he now dreaded it, and six years after, when he was apprenticed to a tanner, he surprised his master by asking, as for a special favor, that they would not force him to smoke leaf-tobacco. Frederick the Great, too, ascribed his abhorrence of the weed to the choking tobacco-fumes of the Wusterhauser club-room, where the boon companions of his awful parent used to indulge from 5 to 12 P. M. It is not necessary to suffocate a child with nicotine-fumes, but it can do no harm to take him

once in a while to a smoker's den, to sniff the "pestilent and penal fires," and let him glory in his blest exemption.

Coffee and tea temptations, pungent spices, etc., may be forestalled in the same way; much is gained if the dietetic innocence of a child has been preserved to the end of the fourteenth year, the age when routine habits first become physiologically confirmed. The habits of the last years of growth become ingrained, as it were, with the constitution of the body, and will bias the physical inclinations of all after-years; circumstances may oblige a man to conform to the customs of a foreign country, the rules of a regimental mess, etc., but, upon the first opportunity of regulating his own regimen, the habits of his boyhood will reassert themselves, even in regard to the time and number of his daily meals. I know from personal experience the unspeakable advantage of having a constitutional predilection for postponing the principal meal till the day's work is done. It was the plan of the ancient Greeks, and to their followers every day is its own reward—the symposium, and the long, undisturbed *siesta* a daily festival. It almost doubles a man's working capacity, by saving him the dire daily struggle between duty and the after-dinner drowsiness. Children who have tried the two methods will rarely hesitate in their choice. Give them a lunch at twelve o'clock, and for breakfast a crust of sweet bran-bread, the coarser the better. A hard crust is the best possible dentifrice. I never could get myself to believe in the natural necessity of a tooth-brush. The African nations, the Hindoos, the natives of Southern Europe, the South-Sea Islanders, the Arabs, the South American vegetarians, in short, three fourths of our fellow-men, besides our next relatives, the frugivorous animals, have splendid teeth without sozodont. I really believe that ours decay from sheer disuse; the boarding-house *homo* lives chiefly on pap—wants all his meats soft-boiled, and growls at cold biscuit or an underdone potato; in other words, he delegates to the cook the proper functions of his teeth. We hear occasionally of old men getting a second, or rather third, set of teeth. I met one of them in northern Guatemala, and ascertained that he had become toothless during a twelve years' sojourn in a seaport town, and that he got his new set upon his return to his native village, where circumstances obliged him to resume the hard corn-cake diet of his boyhood years. His teeth had reappeared, as soon as their services were called for, and would probably never have absented themselves if a pap-diet had not made them superfluous. An artificial dentifrice will certainly keep the teeth white, but that does not prevent their premature decay; disuse gradually softens their substance, till one fine day the hash-eater snaps his best incisor upon an unexpected piece of bone. Every old dentist knows hundreds of city customers whom the daily use of a tooth-brush did not save from the necessity of applying, before the end of the fortieth year, for a complete "celluloid set." I do not say that a soft tooth-brush and such dentifrices

as oatmeal or burned arrow-root can do any harm, but, for sanitary purposes, such precautions must be supplemented by *dental exercise.* Let a child invigorate its teeth by chewing a hard crust, or, better yet, a handful of "St. John's bread" or carob-beans, the edible pod of the *Mimosa siliqua.* Children and whole tribes of the northern races seem to feel an instinctive desire to exercise their teeth upon some solid substance, as pet squirrels will gnaw the furniture if you give them nut-kernels instead of nuts. Thus Kohl tells us that the natives of southern Russia are addicted to the practice of chewing a vegetable product which he at first supposed to be pumpkin or melon seeds, but found to be the much harder seed of the Turkish sunflower (*Helianthus perennis*). Their national diet consists of milk, *kukuruz* (hominy, with butter, etc.), and boiled mutton, and they seem to feel that their Turkoman jaws need something more substantial. The schoolboy habit of gnawing pen-holders, finger-nails, etc., may have a similar significance. The *Mimosa siliqua* would yield abundantly in our Southern States, and its sweet pods would make an excellent substitute for chewing-gum. Our practice of sipping ice-cold and steaming-hot drinks, turn about, has also a very injurious effect upon the brittle substance that forms the enamel of our teeth; no porcelain-glaze would stand such abuse for any length of time, and experience has taught hunters and dog-fanciers that it destroys even the bone-crushing fangs of the animal from which our canine teeth derive their name.

Various diseases of the eye, including myopia, strumous and catarrhal ophthalmia, are due to a scrofulous diathesis, and sometimes to a general debility, and can be radically cured only by out-door exercise and a more nutritious diet. But a transient "weak-sightedness" (*Schwach-sichtigkeit*, as the Germans call it), is eminently a disease of the school-room, caused by a persistent abuse of the eyes, poring for hours together over a spelling-book or writing by the light of a flickering candle (much worse than twilight), as well as by the wretched print of our modern dictionaries and cheap cyclopædias. It should be kept in mind that reading and writing, even under the most favorable circumstances, require an effort to which the eye can only very gradually accustom itself. Hereditary influences and the preliminary exercises of the infant's eye, as, in examining picture-books, the first graphic essays with a slate-pencil, etc., may help to smooth the difficulty; for it is a fact, attested by the experience of all school-teaching missionaries, that the eyes of an adult, sharp-sighted savage begin to smart and water at the first attempt to decipher the hieroglyphics of his primer. The rudiments ought to be taught in half-hour lessons, with liberal intervals of rest and out-door play; and scrofulous children should never be sent to a public school till after a novitiate of at least six months of home studies. Instruct them never to pore over a book, but to keep the head erect, and, at the first symptoms of dim-sighted-

ness, to let the eyes rest upon some distant object, till the optic nerve has recovered from the short-range strain. The hues of the forest have a wonderfully strengthening influence upon weak eyes, almost like its air upon weak lungs; a woodland excursion is like a return to our native element, the birth-land to whose life-conditions the organs of our ancestors were originally adapted.

Accidents can not be avoided by keeping a boy in his nurse's arms or in a padded family coach. Sooner or later he will have to rely on his own limbs, and it is best that time should find him well prepared. Let him rough it, barefoot and bareheaded; let him climb hills and take short cuts over fences and ravines; every fall, every skinned elbow and bumped head, will impart a lesson in the art of locomotion. Without apprentice-fees of that sort he will never get to be a master. I would even connive at an occasional rough-and-tumble fight with a wild comrade; it will acquaint him with what Talleyrand used to call the "esoteric reason for preserving the peace." Constructiveness, too, often the redeeming propensity of a young scapegrace, has its dangers which had better be mastered than avoided. Instead of lecturing a lad or taking away his pocket-knife for cutting his finger, engage a carpenter to teach him the proper use of edge-tools. Let him have a little workshop of his own, with a lot of scrap-tin, boards, nails, and a five-dollar tool-box. Ten to one that those five dollars will save ten cents a week for dime-novels, and, by-and-by, ten dollars a month for beer and tobacco. If your son should manifest symptoms of the collecting-mania, try to direct it to objects of natural history—herbs, beetles, or butterflies. It may lead to deeper studies, and the love of nature in general. A passion for the study of natural history has often turned the scales in a choice between a farm and a dry-goods prison.

"On a visit to Paris," says Carl Weber ("Democritos," vol. ix, p. 166), "the Mentor of a young man, after a trip to the Jardin des Plantes, should not fail to take him to Bertrand Rival's Anatomical Waxwork Museum. It is no misnomer if Bertrand calls his collection '*Musée physiologique, historique et morale*'—intended not only to instruct but to warn the visitor. *Salus tota illa sapere est.*" As a last resort, perhaps, but hardly before the twentieth year. Precocious prurience is due to causes which can generally be avoided. If you can educate the younger children at home and select their playmates, there is no real danger before the eleventh year of a boy and the ninth of a girl. After that, the following precautions will suffice in all but the unluckiest cases: Let your children have plenty of out-door play, especially in the evening. Wait till they are really sleepy before you send them to bed. Let every child have its own bed, or at least its own bedclothes. Keep your small boys out of the servants' room, and your girls after their tenth year; with girls under ten there is less danger: they are quite sure to tell about any improper thing they see

or hear, and the servants seem to know that instinctively. Do not leave them alone with elder children—not even with their own neighbors' and relatives'—till you have satisfied yourself about the character of their new friends. No need of a phrenologist to settle that point: the indications of a child's propensities are not confined to the cranium. Vary the child's diet with the season; put the flesh-pots aside when the approach of the summer solstice threatens the land with the temperatures and temptations of southern Italy. Let them avoid all greasy-made dishes when it is too warm to take much out-door exercise. And, if possible, cultivate their literary taste to the degree that enables them to appreciate the wit or the common-sense of an author, as well as his imagination, and consequently to loathe unmitigated absurdities. That alone will be an effectual safeguard against ninety-nine dime-novels out of a hundred.

In conclusion, I will add a short miscellany of hygienic rules and aphorisms.

The first thing a child should learn is to ask for a drink of water. I have seen hand-fed children scream and fidget for hours together, as if troubled by some unsatisfied want, but at the same time rejecting the milk-bottle and pap-dish with growing impatience. In nine such cases out of ten the nurse will either resort to paregoric or try the effect of a lullaby. I need not say that the poison-expedient would be wrong under all circumstances, but, before you try anything else, offer the child a cup of cold water. To a young nursling the mother's breast supplies both food and drink, but farinaceous paps require a better diluent than milk.

If I should name the greatest danger of childhood, I would unhesitatingly say, Medicine. A drastic drug as a remedial agent is Beelzebub in the *rôle* of an exorcist.

Our nursery system, after all reforms, is still far from being the right one—how far, we may infer from the fact that we have not yet learned to make our babies behave as well as young animals.

Tight-swaddling, strait-jacket gowns, and trailing petticoats—restraint, in short, makes our infants so peevish. If we would give them a chance to use their limbs they would have no time to scream.

It would prevent innumerable diseases if people would learn to distinguish a morbid appetency from a healthy appetite. One diagnostic rule is this, that the gratification of the latter is not followed by repentance; another, that the former has to be artificially and painfully acquired: our better nature resists the incipience of a morbid "second nature." After acquitting Nature from all responsibility for such factitious appetites, it may be justly said that a man can find a road to health and happiness by simply following his instincts.

The supposed danger of cold drinks on a hot day is a very expensive superstition. It deprives thousands of people of the most pleasurable sensation the human palate is capable of. It is worth a two hours'

*anabasis* in the dog-days to drink your fill at the coldest rock-spring of the mountains.

Bathing in flannel!—I would as soon take ice-cream in capsules. The price of the flannel suit would buy you a season-ticket to a lonely beach.

A disposition to excessive perspiration is often due to general debility, but there is a specific remedy for it. Fill your knapsack with substantials and take a pedestrian trip in midsummer, up-hill, if possible, and without loitering under the shade-trees; in short, give your body something worth perspiring for. After that it will be less lavish of gratuitous performances of that sort. The soldiers of the Legion Étrangère are mostly northmen—Poles, Belgians, and Russians—but upon their return from a year's service in Algiers it takes a long double-quick under a Mediterranean sun to drill them into a sweat.

"A catarrh is the beginning of a lung-disease." It would be the end of it if we did not aggravate it with nostrums and fusty sick-rooms.

Somehow or other we must have abused our teeth shamefully before Nature had to resort to such a veto as toothache.

A tooth pulled in time saves nine.

"If you doubt whether a contemplated act is right or wrong," says Zoroaster, "it is the safest plan to omit it." Let dyspeptics remember that when they hesitate at the brink of another plateful.

The digestion of superfluous food almost monopolizes the vital energy; hence the mental and physical indolence of great eaters. Strong-headed business-men manage to conquer that indolence, but only by an effort that would have made the fortune of a temperate eater.

A glutton will find it easier to reduce the number of his meals than the number of his dishes.

Highland children are the healthiest, and, even starving, the happiest. "There is no joy the town can give like those it takes away."

Paracelsus informs us that the composition of his "triple panacea" can be described only in the language of alchemistic adepts. Nature's triple panacea is less indescribable—fasting, fresh air, and exercise.

A banquet without fruit is a garden without flowers.

The best stuff for summer-wear: one stratum of the lightest mosquito-proof linen.

"Do animals ever go to the gymnasium?" asks an opponent of the movement cure. Never: they have no time—they are too busy practicing gymnastics out-doors.

Descent from a long-lived race is not always a guarantee of longevity. A far more important point is the sanitary condition of the parents at the birth of the child. Pluck, however, is hereditary, and has certainly a prophylactic, a "health-compelling" influence.

The first gray hairs are generally a sign of *dear-bought* wisdom.

The "breaking-up" of a pulmonary disease could often be accomplished by breaking the bedroom-windows.

Death, formerly the end of health, is nowadays the end of a disease.

Dying a natural death is one of the lost arts.

There seems to be a strange *fatum* in the association of astronomy with humbug: formerly in horoscopes, and now in patent-medicine almanacs.

A patent-medicine man is generally the patentee of a device for selling whisky under a new name.

A "chronic disease," properly speaking, is nothing but Nature's protest against a chronic provocation. To say that chronic complaints end only with death, means, in fact, that there is generally no other cure for our vices.

Every night labors to undo the physiological mischief of the preceding day—at what expense, gluttons may compute if they compare the golden dreams of their childhood with the leaden torpor-slumbers of their pork and lager-beer years.

If it were not for calorific food and superfluous garments, midsummer would be the most pleasant time of the year.

## A HALF-CENTURY OF SCIENCE.*

By Sir JOHN LUBBOCK.

### I.

IN the name of the British Association, which for the time I very unworthily represent, I beg to tender to you, my Lord Mayor, and through you to the city of York, our cordial thanks for your hospitable invitation and hearty welcome. We feel, indeed, that in coming to York we were coming home: gratefully as we acknowledge and much as we appreciate the kindness we have experienced elsewhere, and the friendly relations which exist between this Association and most—I might even say all—our great cities, yet Sir R. Murchison truly observed, at the close of our first meeting in 1831, that to York, "as the cradle of the Association, we shall ever look back with gratitude; and whether we meet hereafter on the banks of the Isis, the Cam, or the Forth, to this spot we shall still fondly revert." Indeed, it would have been a matter of much regret to all of us if we had not been able on this, our fiftieth anniversary, to hold our meeting in our mother city.

My Lord Mayor, before going further, I must express my regret, especially when I call to mind the illustrious men who have preceded

* Presidential address before the York Meeting of the British Association for the Advancement of Science.

me in this chair, that it has not fallen to one of my eminent friends around me to preside on this auspicious occasion. Conscious, however, as I am of my own deficiencies, I feel that I must not waste time in dwelling on them, more especially as in doing so I should but give them greater prominence. I will, therefore, only make one earnest appeal to your kind indulgence.

The connection of the British Association with the city of York does not depend merely on the fact that our first meeting was held here. It originated in a letter addressed by Sir D. Brewster to Professor Phillips, as Secretary to your York Philosophical Society, by whom the idea was warmly taken up. The first meeting was held on September 26, 1831, the chair being taken by Lord Milton, who delivered an address, after which Mr. William Vernon Harcourt, chairman of the Committee of Management, submitted to the meeting a code of rules which had been so maturely considered and so wisely framed, that they have remained substantially the same down to the present day. The constitution and objects of the Association were so ably described by Mr. Spottiswoode, at Dublin, and are so well known to you, that I will not dwell on them this evening. The excellent President of the Royal Society, in the same address, suggested that the past history of the Association would form an appropriate theme for the present meeting. The history of the Association, however, is really the history of science, and I long shrank from the attempt to give even a panoramic survey of a subject so vast and so difficult; nor should I have ventured to make any such attempt, but that I knew I could rely on the assistance of friends in every department of science.

Certainly, however, this is an opportunity on which it may be well for us to consider what have been the principal scientific results of the last half-century, dwelling especially on those with which this Association is more directly concerned, either as being the work of our own members or as having been made known at our meetings. It is, of course, impossible within the limits of a single address to do more than allude to a few of these, and that very briefly. In dealing with so large a subject, I first hoped that I might take our annual volumes as a text-book. This, however, I at once found to be quite impossible. For instance, the first volume commences with a Report on Astronomy by Sir G. Airy; I may be pardoned, I trust, for expressing my pleasure at finding that the second was one by my father, on the Tides, prepared, like the preceding, at the request of the council; then comes one on Meteorology by Forbes; Radiant Heat by Baden Powell; Optics by Brewster; Mineralogy by Whewell, and so on. My best course will therefore be to take our different sections one by one, and endeavor to bring before you a few of the principal results which have been obtained in each department.

The Biological Section is that with which I have been most intimately associated, and with which it is, perhaps, natural that I should

begin. Fifty years ago it was the general opinion that animals and plants came into existence just as we now see them. We took pleasure in their beauty; their adaptation to their habits and mode of life in many cases could not be overlooked or misunderstood. Nevertheless, the book of Nature was like some richly illuminated missal, written in an unknown tongue; the graceful forms of the letters, the beauty of the coloring, excited our wonder and admiration; but of the true meaning little was known to us; indeed, we scarcely realized that there was any meaning to decipher. Now glimpses of the truth are gradually revealing themselves; we perceive that there is a reason —and in many cases we know what that reason is—for every difference in form, in size, and in color; for every bone and every feather, almost for every hair. Moreover, each problem which is solved opens out vistas, as it were, of others perhaps even more interesting. With this great change the name of our illustrious countryman, Darwin, is intimately associated, and the year 1859 will always be memorable in science as having produced his great work on "The Origin of Species." In the previous year he and Wallace had published short papers, in which they clearly state the theory of natural selection, at which they had simultaneously and independently arrived. We can not wonder that Darwin's views should have at first excited great opposition. Nevertheless, from the first they met with powerful support, especially in this country, from Hooker, Huxley, and Herbert Spencer. The theory is based on four axioms:

"1. That no two animals or plants in nature are identical in all respects. 2. That the offspring tend to inherit the peculiarities of their parents. 3. That of those which come into existence, only a small number reach maturity. 4. That those which are, on the whole, best adapted to the circumstances in which they are placed are most likely to leave descendants."

Darwin commenced his work by discussing the causes and extent of variability in animals, and the origin of domestic varieties; he showed the impossibility of distinguishing between varieties and species, and pointed out the wide differences which man has produced in some cases—as, for instance, in our domestic pigeons, all unquestionably descended from a common stock. He dwelt on the struggle for existence (which has since become a household word), and which, inevitably resulting in the survival of the fittest, tends gradually to adapt any race of animals to the conditions in which it occurs. While thus, however, showing the great importance of natural selection, he attributed to it no exclusive influence, but fully admitted that other causes—the use and disuse of organs, sexual selection, etc.—had to be taken into consideration. Passing on to the difficulties of his theory, he accounted for the absence of intermediate varieties between species, to a great extent, by the imperfection of the geological record. But, if the geological record be imperfect, it is still very instructive. The

further paleontology has progressed, the more it has tended to fill up the gaps between existing groups and species; while the careful study of living forms has brought into prominence the variations dependent on food, climate, habitat, and other conditions, and shown that many species, long supposed to be absolutely distinct, are so closely linked together by intermediate forms that it is difficult to draw a satisfactory line between them.

The principles of classification point also in the same direction, and are based more and more on the theory of descent. Biologists endeavor to arrange animals on what is called the "natural system." No one now places whales among fish, bats among birds, or shrews with mice, notwithstanding their external similarity; and Darwin maintained that "community of descent was the hidden bond which naturalists had been unconsciously seeking." How else, indeed, can we explain the fact that the framework of bones is so similar in the arm of a man, the wing of a bat, the foreleg of a horse, and the fin of a porpoise—that the neck of a giraffe and that of an elephant contain the same number of vertebræ?

Strong evidence is, moreover, afforded by embryology; by the presence of rudimentary organs and transient characters, as, for instance, the existence in the calf of certain teeth which never cut the gums, the shriveled and useless wings of some beetles, the presence of a series of arteries in the embryos of the higher vertebrata exactly similar to those which supply the gills in fishes, even the spots on the young blackbird, the stripes on the lion's cub; these, and innumerable other facts of the same character, appear to be incompatible with the idea that each species was specially and independently created; and to prove, on the contrary, that the embryonic stages of species show us more or less clearly the structure of their ancestors.

Darwin's views, however, are still much misunderstood. I believe there are thousands who consider that according to his theory a sheep might turn into a cow, or a zebra into a horse. No one would more confidently withstand any such hypothesis, his view being, of course, not that the one could be changed into the other, but that both are descended from a common ancestor. No one, at any rate, will question the immense impulse which Darwin has given to the study of natural history, the number of new views he has opened up, and the additional interest which he has aroused in, and contributed to, biology. When we were young, we knew that the leopard had spots, the tiger was striped, and the lion tawny; but why this was so it did not occur to us to ask; [and, if we had asked], no one would have answered. Now we see at a glance that the stripes of the tiger have reference to its life among jungle-grasses; the lion is sandy, like the desert; while the markings of the leopard resemble spots of sunshine glancing through the leaves.

The science of embryology may almost be said to have been cre-

ated in the last half-century. Fifty years ago it was a very general opinion that animals which are unlike when mature were dissimilar from the beginning. It is to Von Baer, the discoverer of the mammalian ovum, that we owe the great generalization that the development of the egg is in the main a progress from the general to the special; in fact, that embryology is the key to the laws of animal development. Thus the young of existing species resemble in many cases the mature forms which flourished in ancient times. Huxley has traced up the genealogy of the horse to the Miocene Anchitherium. In the same way Gaudry has called attention to the fact that, just as the individual stag gradually acquires more and more complex antlers—having at first only a single prong, in the next year two points, in the following three, and so on—so the genus, as a whole, in Middle Miocene times had two pronged horns; in the Upper Miocene, three; and that it is not till the Upper Pliocene that we find any species with the magnificent antlers of our modern deer. It seems to be now generally admitted that birds have come down to us through the Dinosaurians, and, as Huxley has shown, the profound break once supposed to exist between birds and reptiles has been bridged over by the discovery of reptilian birds and bird-like reptiles; so that, in fact, birds are modified reptiles. Again, the remarkable genus *Peripatus*, so well studied by Moseley, tends to connect the annulose and articulate types.

Again, the structural resemblances between Amphioxus and the Ascidians had been pointed out by Goodsir; and Kowalevsky in 1866 showed that these were not mere analogies, but indicated a real affinity. These observations, in the words of Allen Thomson, "have produced a change little short of revolutionary in embryological and zoölogical views, leading as they do to the support of the hypothesis that the Ascidian is an earlier stage in the phylogenetic history of the mammal and other vertebrates."

The larval forms which occur in so many groups, and of which the insects afford us the most familiar examples, are, in the words of Quatrefages, embryos, which lead an independent life. In such cases as these, external conditions act upon the larvæ as they do upon the mature form; hence we have two classes of changes, adaptational or adaptive, and developmental. These and many other facts must be taken into consideration; nevertheless, naturalists are now generally agreed that embryological characters are of high value as guides in classification, and it may, I think, be regarded as well established that, just as the contents and sequence of rocks teach us the past history of the earth, so is the gradual development of the species indicated by the structure of the embryo and its developmental changes. When the supporters of Darwin are told that his theory is incredible, they may fairly ask why it is impossible that a species in the course of hundreds of thousands of years should have passed through changes which occupy only a few days or weeks in the life-history of each individual.

The phenomena of yolk-segmentation, first observed by Prevost and Dumas, are now known to be in some form or other invariably the precursors of embryonic development; while they reproduce, as the first stages in the formation of the higher animals, the main and essential features in the life-history of the lowest forms. The "blastoderm," as it is called, or first germ of the embryo in the egg, divides itself into two layers, corresponding, as Huxley has shown, to the two layers into which the body of the *Cœlenterata* may be divided. Not only so, but most embryos at an early stage of development have the form of a cup, the walls of which are formed by the two layers of the blastoderm. Kowalevsky was the first to show the prevalence of this embryonic form, and subsequently Lankester and Haeckel put forward the hypothesis that it was the embryonic repetition of an ancestral type, from which all the higher forms are descended. The cavity of the cup is supposed to be the stomach of this simple organism, and the opening of the cup the mouth. The inner layer of the wall of the cup constitutes the digestive membrane, and the outer the skin. To this form Haeckel gave the name *Gastræa*. It is perhaps doubtful whether the theory of Lancaster and Haeckel can be accepted in precisely the form they propounded it; but it has had an important influence on the progress of embryology. I can not quit the science of embryology without alluding to the very admirable work on "Comparative Embryology" by our new general secretary, Mr. Balfour, and also the "Elements of Embryology" which he had previously published in conjunction with Dr. M. Foster.

In 1842 Steenstrup published his celebrated work on the "Alternation of Generations," in which he showed that many species are represented by two perfectly distinct types or broods, differing in form, structure, and habits; that in one of them males are entirely wanting, and that the reproduction is effected by fission, or by buds, which, however, are in some cases structurally indistinguishable from eggs. Steenstrup's illustrations were mainly taken from marine or parasitic species, of very great interest, but not generally familiar, excepting to naturalists. It has since been shown that the common *Cynips*, or gall-fly, is also a case in point. It had long been known that in some genera belonging to this group males are entirely wanting, and it has now been shown by Bassett, and more thoroughly by Adler, that some of these species are double-brooded; the two broods having been considered as distinct genera. Thus, an insect known as *Neuroterus lenticularis*, of which females only occur, produces the familiar oak-spangles so common on the under sides of oak-leaves, from which emerge, not *Neuroterus lenticularis*, but an insect hitherto considered as a distinct species, belonging even to a different genus (*Spathegaster baccarum*). In Spathegaster both sexes occur; they produce the currant-like galls found on oaks, and from these galls Neuroterus is again developed. So also the King Charles oak-apples produce a species known as *Teras terminalis*,

which descends to the ground, and makes small galls on the roots of the oak. From these emerge an insect known as *Biorhiza aptera*, which again gives rise to the common oak-apple.

It might seem that such inquiries as these could hardly have any practical bearing. Yet it is not improbable that they may lead to very important results. For instance, it would appear that the fluke which produces the rot in sheep, passes one phase of its existence in the black slug; and we are not without hopes that the researches, in which our lamented friend Professor Rolleston was engaged at the time of his death, which we all so much deplore, will lead, if not to the extirpation, at any rate to the diminution, of a pest from which our farmers have so grievously suffered.

It was in the year 1839 that Schwann and Schleiden demonstrated the intimate relation in which animals and plants stand to each other, by showing the identity of the laws of development of the elementary parts in the two kingdoms of organic nature.

As regards descriptive biology, by far the greater number of species now recorded have been named and described within the last half-century. Dr. Günther has been good enough to make a calculation for me. The numbers, of course, are only approximate, but it appears that, while the total number of animals described up to 1831 was not more than 70,000, the number now is at least 320,000.

Lastly, to show how large a field still remains for exploration, I may add that Mr. Waterhouse estimates that the British Museum alone contains not fewer than 12,000 species of insects which have not yet been described, while our collections do not probably contain anything like one half of those actually in existence. Further than this, the anatomy and habits even of those which have been described offer an inexhaustible field for research, and it is not going too far to say that there is not a single species which would not amply repay the devotion of a lifetime.

One remarkable feature in the modern progress of biological science has been the application of improved methods of observation and experiment, and the employment in physiological research of the exact measurements employed by the experimental physicist. Our microscopes have been greatly improved. The use of chemical reagents in microscopical investigations has proved most instructive, and another very important method of investigation has been the power of obtaining very thin slices by imbedding the object to be examined in paraffine or some other soft substance. In this manner we can now obtain, say, fifty separate sections of the egg of a beetle or the brain of a bee.

At the close of the last century Sprengel published a most suggestive work on flowers, in which he pointed out the curious relation existing between these and insects, and showed that the latter carry the pollen from flower to flower. His observations, however, attracted little notice until Darwin called attention to the subject in 1862. It

had long been known that the cowslip and primrose exist under two forms, about equally numerous, and differing from one another in the arrangements of their stamens and pistils; the one form having the stamens on the summit of the flower and the stigma half-way down, while in the other the relative positions are reversed, the stigma being at the summit of the tube and the stamens half-way down. This difference had, however, been regarded as a case of mere variability; but Darwin showed it to be a beautiful provision, the result of which is that insects fertilize each flower with pollen brought from a different plant; and he proved that flowers fertilized with pollen from the other form yield more seed than if fertilized with pollen of the same form, even if taken from a different plant.

Attention having been thus directed to the question, an astonishing variety of most beautiful contrivances has been observed and described by many botanists, especially Hooker, Axel, Delpino, Hildebrand, Bennett, Fritz Müller, and, above all, Hermann Müller and Darwin himself. The general result is that to insects, and especially to bees, we owe the beauty of our gardens, the sweetness of our fields. To their beneficent though unconscious action flowers owe their scent and color, their honey—nay, in many cases, even their form. Their present shape and varied arrangements, their brilliant colors, their honey, and their sweet scent are all due to the selection exercised by insects. In these cases the relation between plants and insects is one of mutual advantage. In many species, however, plants present us with complex arrangements adapted to protect them from insects; such, for instance, are in many cases the resinous glands which render leaves unpalatable; the thickets of hairs and other precautions which prevent flowers from being robbed of their honey by ants. Again, more than a century ago our countryman, Ellis, described an American plant, *Dionæa*, in which the leaves are somewhat concave, with long lateral spines and a joint in the middle; close up with a jerk like a rat-trap the moment any unwary insect alights on them. The plant, in fact, actually captures and devours insects. This observation also remained as an isolated fact until within the last few years, when Darwin, Hooker, and others have shown that many other species have curious and very varied contrivances for supplying themselves with animal food.

Some of the most fascinating branches of botany—morphology, histology, and physiology—scarcely existed before 1830. In the two former branches the discoveries of Von Mohl are preëminent. He first observed cell-division in 1835, and detected the presence of starch in chlorophyl-corpuscles in 1837, while he first described protoplasm, now so familiar to us, at least by name, in 1846. In the same year Amici discovered the existence of the embryonic vesicle in the embryo sac, which develops into the embryo when fertilized by the entrance of the pollen-tube into the micropyle. The existence of sexual repro-

duction in the lower plants was doubtful, or at least doubted by some eminent authorities, as recently as 1853, when the actual process of fertilization in the common bladderwrack of our shores was observed by Thuret, while the reproduction of the larger fungi was first worked out by De Bary in 1863.

As regards lichens, Schwendener proposed, in 1869, the startling theory, now, however, accepted by some of the highest authorities, that lichens are not autonomous organisms, but commensal associations of a fungus parasitic on an alga. With reference to the higher cryptogams it is hardly too much to say that the whole of our exact knowledge of their life-history has been obtained during the last half-century. Thus, in the case of ferns, the male organs, or antheridia, were first discovered by Nägeli in 1844, and the archegonia, or female organs, by Suminski in 1848. The early stages in the development of mosses were worked out by Valentine in 1833. Lastly, the principle of alternation of generations in plants was discovered by Hofmeister. This eminent naturalist also, in 1851–'54, pointed out the homologies of the reproductive processes in mosses, vascular cryptogams, gymnosperms, and angiosperms.

Nothing could have appeared less likely than that researches into the theory of spontaneous generation should have led to practical improvements in medical science. Yet such has been the case. Only a few years ago bacteria seemed mere scientific curiosities. It had long been known that an infusion—say, of hay—would, if exposed to the atmosphere, be found, after a certain time, to teem with living forms. Even those few who still believe that life would be spontaneously generated in such an infusion, will admit that these minute organisms are, if not entirely, yet mainly, derived from germs floating in our atmosphere; and, if precautions are taken to exclude such germs, as in the careful experiments especially of Pasteur, Tyndall, and Roberts, every one will grant that in ninety-nine cases out of a hundred no such development of life will take place. These facts have led to most important results in surgery. One reason why compound fractures are so dangerous, is because, the skin being broken, the air obtains access to the wound, bringing with it innumerable germs, which too often set up putrefying action. Lister first made a practical application of these observations. He set himself to find some substance capable of killing the germs, without being itself too potent a caustic, and he found that dilute carbolic acid fulfilled these conditions. This discovery has enabled many operations to be performed which would previously have been almost hopeless.

The same idea seems destined to prove as useful in medicine as in surgery. There is great reason to suppose that many diseases, especially those of a zymotic character, have their origin in the germs of special organisms. We know that fevers run a certain definite course. The parasitic organisms are at first few, but gradually multiply at the

expense of the patient, and then die out again. Indeed, it seems to be thoroughly established that many diseases are due to the excessive multiplication of microscopic organisms, and we are not without hope that means will be discovered by which, without injury to the patient, these terrible though minute enemies may be destroyed, and the disease thus stayed. The interesting researches of Burdon-Sanderson, Greenfield, Koch, Pasteur, Toussaint, and others, seem to justify the hope that we may be able to modify these and other germs, and then by appropriate inoculation to protect ourselves against fever and other acute diseases.

The history of anæsthetics is a most remarkable illustration of how long we may be on the very verge of a most important discovery. Ether, which, as we all know, produces perfect insensibility to pain, was discovered as long ago as 1540. The anæsthetic property of nitrous oxide, now so extensively used, was observed in 1800 by Sir H. Davy, who actually experimented on himself, and had one of his teeth painlessly extracted when under its influence. He even suggests that, "as nitrous oxide gas seems capable of destroying pain, it could probably be used with advantage in surgical operations." Nay, this property of nitrous oxide was habitually explained and illustrated in the chemical lectures given in hospitals, and yet for fifty years the gas was never used in actual operations.

Few branches of science have made more rapid progress in the last half-century than that which deals with the ancient condition of man. When our Association was founded, it was generally considered that the human race suddenly appeared on the scene, about six thousand years ago, after the disappearance of the extinct mammalia, and when Europe, both as regards physical conditions and the other animals by which it was inhabited, was pretty much in the same condition as in the period covered by Greek and Roman history. Since then the persevering researches of Layard, Rawlinson, Botta, and others have made known to us, not only the statues and palaces of the ancient Assyrian monarchs, but even their libraries ; the cuneiform characters have been deciphered, and we can not only see, but read in the British Museum, the actual contemporary records, on burned-clay cylinders, of the events recorded in the historical books of the Old Testament and in the pages of Herodotus. The researches in Egypt also seem to have satisfactorily established the fact that the pyramids themselves are at least six thousand years old, while it is obvious that the Assyrian and Egyptian monarchies can not suddenly have attained to the wealth and power, the state of social organization, and progress in the arts, of which we have before us, preserved by the sand of the desert from the ravages of man, such wonderful proofs.

In Europe, the writings of the earliest historians and poets indicated that, before iron came into general use, there was a time when bronze was the ordinary material of weapons, axes, and other cutting

implements, and though it seemed *a priori* improbable that a compound of copper and tin should have preceded the simple metal iron, nevertheless, the researches of archæologists have shown that there really was in Europe a "bronze age," which at the dawn of history was just giving way to that of "iron." The contents of ancient graves, buried in many cases so that their owner might carry some at least of his wealth with him to the world of spirits, left no room for doubt as to the existence of a bronze age; but we get a completer idea of the condition of man at this period from the Swiss lake-villages, first made known to us by Keller. Along the shallow edges of the Swiss lakes there flourished, once upon a time, many populous villages or towns, built on platforms supported by piles, exactly as many Malayan villages are now. Under these circumstances innumerable objects were one by one dropped into the water; sometimes whole villages were burned, and their contents submerged; and thus we have been able to recover, from the waters of oblivion in which they had rested for more than two thousand years, not only the arms and tools of this ancient people, the bones of their animals, their pottery and ornaments, but the stuffs they wore, the grain they had stored up for future use, even fruits and cakes of bread.

But this bronze-using people were not the earliest occupants of Europe. The contents of ancient tombs give evidence of a time when metal was unknown. This also was confirmed by the evidence then unexpectedly received from the Swiss lakes. By the side of the bronze-age villages were others, not less extensive, in which, while implements of stone and bone were discovered literally by thousands, not a trace of metal was met with. The shell-mounds, or refuse-heaps, accumulated by the ancient fishermen along the shores of Denmark, fully confirmed the existence of a "stone age."

No bones of the reindeer, no fragment of any of the extinct mammalia, have been found in any of the Swiss lake-villages or in any of the thousands of tumuli which have been opened in our own country, or in Central and Southern Europe. Yet the contents of caves and of river-gravels afford abundant evidence that there was a time when the mammoth and rhinoceros, the musk-ox and reindeer, the cave-lion and hyena, the great bear and the gigantic Irish elk wandered in our woods and valleys, and the hippopotamus floated in our rivers; when England and France were united, and the Thames and the Rhine had a common estuary. This was long supposed to be before the advent of man. At length, however, the discoveries of Boucher de Perthes in the valley of the Somme, supported as they are by the researches of many Continental naturalists, and in our own country of MacEnery and Godwin-Austen, Prestwich and Lyell, Vivian and Pengelly, Christy, Evans, and many more, have proved that man formed a humble part of this strange assembly. Nay, even at this early period there were at least two distinct races of men in Europe; one of them—as

Boyd Dawkins has pointed out—closely resembling the modern Esquimau in form, in his weapons and implements, probably in his clothing, as well as in so many of the animals with which he was associated.

At this stage man appears to have been ignorant of pottery, to have had no knowledge of agriculture, no domestic animals, except, perhaps, the dog. His weapons were the axe, the spear, and the javelin; I do not believe he knew the use of the bow, though he was probably acquainted with the lance. He was, of course, ignorant of metal, and his stone implements, though skillfully formed, were of quite different shapes from those of the second stone age, and were never ground. This earlier stone period, when man coexisted with these extinct mammalia, is known as the Palæolithic or Early Stone Age, in opposition to the Neolithic or Newer Stone Age. The remains of the mammalia which coëxisted with man in prehistoric times have been most carefully studied by Owen, Lartet, Rütimeyer, Falconer, Busk, Boyd Dawkins, and others. The presence of the mammoth, the reindeer, and especially of the musk-ox, indicates a severe, not to say an arctic climate, the existence of which, moreover, was proved by other considerations; while, on the contrary, the hippopotamus requires considerable warmth. How, then, is this association to be explained?

While the climate of the globe is, no doubt, much affected by geographical conditions, the cold of the glacial period was, I believe, mainly due to the eccentricity of the earth's orbit, combined with the obliquity of the ecliptic. The result of the latter condition is a period of twenty-one thousand years, during one half of which the northern hemisphere is warmer than the southern, while during the other ten thousand five hundred years the reverse is the case. At present we are in the former phase, and there is, we know, a vast accumulation of ice at the south pole. But when the earth's orbit is nearly circular, as it is at present, the difference between the two hemispheres is not very great; on the contrary, as the eccentricity of the orbit increases, the contrast between them increases also. This eccentricity is continually oscillating within certain limits, which Croll and subsequently Stone have calculated out for the last million years. At present, the eccentricity is ·016, and the mean temperature of the coldest month in London is about 40°. Such has been the state of things for nearly one hundred thousand years; but before that there was a period, beginning three hundred thousand years ago, when the eccentricity of the orbit varied from ·26 to ·57. The result of this would be greatly to increase the effect due to the obliquity of the orbit; at certain periods the climate would be much warmer than at present, while at others the number of days in winter would be twenty more, and of summer twenty less than now, while the mean temperature of the coldest month would be lowered 20°. We thus get something like a date for the last glacial epoch, and we see that it was not simply a period of cold, but rather one of extremes, each beat of the pendulum

of temperature lasting for no less than twenty-one thousand years. This explains the fact that, as Morlot showed in 1854, the glacial deposits of Switzerland, and, as we now know, those of Scotland, are not a single uniform layer, but a succession of strata indicating very different conditions. I agree also with Croll and Geikie in thinking that these considerations explain the apparent anomaly of the coexistence in the same gravels of arctic and tropical animals; the former having lived in the cold, while the latter flourished in the hot, periods.

It is, I think, now well established that man inhabited Europe during the milder periods of the glacial epoch. Some high authorities, indeed, consider that we have evidence of his presence in pre-glacial and even in Miocene times, but I confess that I am not satisfied on this point. Even the more recent period carries back the record of man's existence to a distance so great as altogether to change our views of ancient history. Nor is it only as regards the antiquity and material condition of man in prehistoric times that great progress has been made. If time permitted, I should have been glad to dwell on the origin and development of language, of custom, and of law. On all of these the comparison of the various lower races, still inhabiting so large a portion of the earth's surface, has thrown much light; while even in the most cultivated nations we find survivals, curious fancies, and lingering ideas, the fossil remains, as it were, of former customs and religions imbedded in our modern civilization, like the relics of extinct animals in the crust of the earth.

In geology the formation of our Association coincided with the appearance of Lyell's "Principles of Geology," the first volume of which was published in 1830, and the second in 1832. At that time the received opinion was that the phenomena of geology could only be explained by violent periodical convulsions, and a high intensity of terrestrial energy culminating in repeated catastrophes. Hutton and Playfair had indeed maintained that such causes as those now in operation would, if only time enough were allowed, account for the geological structure of the earth; nevertheless, the opposite view generally prevailed, until Lyell, with rare sagacity and great eloquence, with a wealth of illustration and most powerful reasoning, convinced geologists that the forces now in action are powerful enough, if only time be given, to produce results quite as stupendous as those which science records.

As regards stratigraphical geology, at the time of the first meeting of the British Association at York, the strata between the carboniferous limestone and the chalk had been mainly reduced to order and classified, chiefly through the labors of William Smith. But the classification of all the strata lying above the chalk and below the carboniferous limestone respectively, remained in a state of the greatest confusion. The year 1831 marks the period of the commencement of the joint labors of Sedgwick and Murchison, which resulted in the estab-

lishment of the Cambrian, Silurian, and Devonian systems. Our pre-Cambrian strata have recently been divided by Hicks into four great groups of immense thickness, and implying, therefore, a great lapse of time; but no fossils have yet been discovered in them. Lyell's classification of the tertiary deposits, the result of the studies which he carried on with the assistance of Deshayes and others, was published in the third volume of the "Principles of Geology" in 1833. The establishment of Lyell's divisions of eocene, miocene, and pliocene, was the starting-point of a most important series of investigations, by Prestwich and others, of these younger deposits, as well of the post-tertiary, quaternary, or drift-beds, which are of special interest from the light they have thrown on the early history of man.

As regards the physical character of the earth, two theories have been held: one, that of a fluid interior covered by a thin crust; the other, of a practically solid sphere. The former is now very generally admitted, both by astronomers and geologists, to be untenable. The prevailing feeling of geologists on this subject has been well expressed by Professor Le Conte, who says, "The whole theory of igneous agencies—which is little less than the whole foundation of theoretic geology—must be reconstructed on the basis of a solid earth."

In 1837 Agassiz startled the scientific world by his "Discours sur l'ancienne Extension des Glaciers," in which, developing the observation already made by Charpentier and Venetz, that bowlders had been transported to great distances, and that rocks far away from, or high above, existing glaciers, are polished and scratched by the action of ice, he boldly asserted the existence of a "glacial period," during which Switzerland and the north of Europe were subjected to great cold and buried under a vast sheet of ice.

The ancient poets described certain gifted mortals as privileged to descend into the interior of the earth, and have exercised their imagination in recounting the wonders there revealed. As in other cases, however, the realities of science have proved more varied and surprising than the dreams of fiction. Of the gigantic and extraordinary animals thus revealed to us, by far the greatest number have been described during the period now under review. For instance, the gigantic cetiosaurus was described by Owen in 1838, the dinornis of New Zealand by the same distinguished naturalist in 1839, the mylodon in the same year, and the archæopteryx in 1862.

In America, a large number of remarkable forms have been described, mainly by Marsh, Leidy, and Cope. Marsh has made known to us the titanosaurus, of the American (Colorado) Jurassic beds, which is, perhaps, the largest land animal yet known, being a hundred feet in length, and at least thirty feet in height, though it seems possible that even these vast dimensions were exceeded by those of the atlantosaurus. Nor must I omit the hesperornis, described by Marsh in 1872, as a carnivorous, swimming ostrich, provided with teeth, which he re-

gards as a character inherited from reptilian ancestors; the ichthyornis, stranger still, with biconcave vertebræ, like those of fishes, and teeth set in sockets.

As giving, in a few words, an idea of the rapid progress in this department, I may mention that Morris's "Catalogue of British Fossils," published in 1843, contained 5,300 species; while that now in preparation by Mr. Etheridge enumerates 15,000. But, if these figures show how rapid our recent progress has been, they also very forcibly illustrate the imperfection of the geological record, and give us, I will not say a measure, but an idea, of the imperfection of the geological record. The number of all the described recent species is over 300,000, but certainly not half are yet on our lists, and we may safely take the total number of recent species as being not less than 700,000. But in former times there have been at the very least twelve periods, in each of which by far the greater number of species were distinct. True, the number of species was probably not so large in the earlier periods as at present; but, if we make a liberal allowance for this, we shall have a total of more than 2,000,000 species, of which about 25,000 only are as yet upon record; and many of these are only represented by a few, some only by a single specimen, or even only by a fragment.

The progress of paleontology may also be marked by the extent to which the existence of groups has been, if I may so say, carried back in time. Thus, I believe that in 1830 the earliest known quadrupeds were small marsupials belonging to the Stonesfield slates; the most ancient mammal now known is *Microlestes antiquus* from the Keuper of Würtemberg; the oldest bird known in 1831 belonged to the period of the London Clay, the oldest now known is the archæopteryx of the Solenhofen slates, though it is probable that some at any rate of the footsteps on the Triassic rocks are those of birds. So, again, the Amphibia have been carried back from the Trias to the Coal-measures; fish from the Old Red Sandstone to the Upper Silurian; reptiles to the Trias; insects from the Cretaceous to the Devonian; Mollusca and Crustacea from the Silurian to the Lower Cambrian. The rocks below the Cambrian, though of immense thickness, have afforded no relics of animal life, if we except the problematical *Eozoön Canadense*, so ably studied by Dawson and Carpenter. But, if paleontology as yet throws no light on the original forms of life, we must remember that the simplest and the lowest organisms are so soft and perishable that they would leave "not a wrack behind."

Passing to the science of geography, Mr. Clements Markham has recently published an excellent summary of what has been accomplished during the half-century. But the progress in our knowledge of geography is, and has been, by no means confined to the improvement of our maps, or to the discovery and description of new regions of the earth, but has extended to the causes which have led to the present configuration of the surface. To a great extent, indeed, this

part of the subject falls rather within the scope of geology, but I may here refer, in illustration, to the distribution of lakes, the phenomena of glaciers, the formation of volcanic mountains, and the structure and distribution of coral islands.

The origin and distribution of lakes is one of the most interesting problems in physical geography. That they are not scattered at random, a glance at the map is sufficient to show. They abound in mountain districts, are comparatively rare in equatorial regions, increasing in number as we go north, so that in Scotland and the northern parts of America they are sown broadcast. Perhaps *a priori* the first explanation of the origin of lakes which would suggest itself, would be that they were formed in hollows resulting from a disturbance of the strata, which had thrown them into a basin-shaped form. Lake-basins, however, of this character are, as a matter of fact, very rare; as a general rule, lakes have not the form of basin-shaped synclinal hollows, but, on the contrary, the strike of the strata often runs right across them. My eminent predecessor, Professor Ramsay, divides lakes into three classes: 1. Those which are due to irregular accumulations of drift, and which are generally quite shallow; 2. Those which are formed by moraines; and, 3, those which occupy true basins scooped by glacier-ice out of the solid rock. To the latter class belong most of the great Swiss and Italian lakes. Professor Ramsay attributes their excavation to glaciers, because it is of course obvious that rivers can not make basin-shaped hollows surrounded by rock on all sides. Now, the Lake of Geneva, 1,230 feet above the sea, is 984 feet deep, the Lake of Brienz is 1,850 feet above the sea, and 2,000 feet deep, so that its bottom is really below the sea-level. The Italian lakes are even more remarkable. The Lake of Como, 700 feet above the sea, is 1,929 feet deep. Lago Maggiore, 685 feet above the sea, is no less than 2,625 feet deep. It will be observed that these lakes, like many others in mountain regions, those of Scandinavia, for instance, lie in the direct channels of the great old glaciers. If the mind is at first staggered at the magnitude of the scale, we must remember that the ice, which scooped out the valley in which the Lake of Geneva now reposes, was once at least 2,700 feet thick; while the moraines were also of gigantic magnitude, that of Ivrea, for instance, being no less than 1,500 feet in height. Professor Ramsay's theory seems, therefore, to account beautifully for a large number of interesting facts.

Passing from lakes to mountains, two rival theories with reference to the structure and origin of volcanoes long struggled for supremacy. The more general view was that the sheets of lava and scoriæ which form volcanic cones—such, for instance, as Etna or Vesuvius—were originally nearly horizontal, and that subsequently a force operating from below, and exerting a pressure both upward and outward from a central axis toward all points of the compass, uplifted the whole stratified mass, and made it assume a conical form, giving rise at the same

time, in many cases, to a wide and deep circular opening at the top of the cone, called by the advocates of this hypothesis a "crater of elevation."

This theory, though, as it seems to us now, it had already received its death-blow from the admirable memoirs of Scrope, was yet that most generally adopted fifty years ago, because it was considered that compact and crystalline lavas could not have consolidated on a slope exceeding 1° or 2°. In 1858, however, Sir Charles Lyell conclusively showed that in fact such lavas could consolidate at a considerable angle, even in some cases at more than 30°, and it is now generally admitted that, though the beds of lava, etc., may have sustained a slight angular elevation since their deposition, still, in the main, volcanic cones have acquired their form by the accumulation of lava and ashes ejected from one or more craters.

The problems presented by glaciers are of very great interest. In 1843 Agassiz and Forbes proved that the center of a glacier, like that of a river, moves more rapidly than its sides. But how and why do glaciers move at all? Rendu, afterward Bishop of Annecy, in 1841 endeavored to explain the facts by supposing that glacier-ice enjoys a kind of ductility. The "viscous theory" of glaciers was also adopted and most ably advocated by Forbes, who compared the condition of a glacier to that of the contents of a tar-barrel poured into a sloping channel. We have all, however, seen long, narrow fissures, a mere fraction of an inch in width, stretching far across glaciers—a condition incompatible with the ordinary idea of viscosity. The phenomenon of regelation was afterward applied to the explanation of glacier-motion. An observation of Faraday's supplied the clew. He noticed in 1850 that, when two pieces of thawing ice are placed together, they unite by freezing at the place of contact. Following up this suggestion, Tyndall found that, if he compressed a block of ice in a mold, it could be made to assume any shape he pleased. A straight prism, for instance, placed in a groove and submitted to hydraulic pressure, was bent into a transparent semicircle of ice. These experiments seem to have proved that a glacial valley is a mold through which the ice is forced, and to which it will accommodate itself, while, as Tyndall and Huxley also pointed out, the "veined structure of ice" is produced by pressure, in the same manner as the cleavage of slate-rocks.

It was in the year 1842 that Darwin published his great work on "Coral Islands." The fringing reefs of coral presented no special difficulty. They could be obviously accounted for by an elevation of the land, so that the coral, which had originally grown under water, had been raised above the sea-level. The circular or oval shape of so many reefs, however, each having a lagoon in the center, closely surrounded by a deep ocean, and rising but a few feet above the sea-level, had long been a puzzle to the physical geographer. The favorite theory was, that these were the summits of submarine volcanoes on which the

coral had grown. But, as the reef-making coral does not live at greater depths than about twenty-five fathoms, the immense number of these reefs formed an almost insuperable objection to this theory. The Laccadives and Maldives, for instance—meaning literally the "lac of islands" and the "thousand islands"—are a series of such atolls, and it was impossible to imagine so great a number of craters, all so nearly of the same altitude. Darwin showed, moreover, that, so far from the ring of corals resting on a corresponding ridge of rock, the lagoons, on the contrary, now occupy the place which was once the highest land. He pointed out that some lagoons, as, for instance, that of Vanikoro, contain an island in the middle; while other islands, such as Tahiti, are surrounded by a margin of smooth water, separated from the ocean by a coral-reef. Now, if we suppose that Tahiti were to sink slowly, it would gradually approximate to the condition of Vanikoro; and, if Vanikoro gradually sank, the central island would disappear, while on the contrary the growth of the coral might neutralize the subsidence of the reef, so that we should have simply an atoll, with its lagoon. The same considerations explain the origin of the "barrier reefs," such as that which runs, for nearly one thousand miles, along the northeast coast of Australia. Thus Darwin's theory explained the form and the approximate identity of altitude of these coral islands. But it did more than this, because it showed us that there were great areas in process of subsidence, which, though slow, was of great importance in physical geography.*

Much information has also been acquired with reference to the abysses of the ocean, especially from the voyages of the Porcupine and the Challenger. The greatest depth yet recorded is near the Ladrone Islands, where a sounding of 4,575 fathoms was obtained. Ehrenberg long ago pointed out the similarity of the calcareous mud now accumulating in our recent seas to the chalk, and showed that the green-sands of the geologist are largely made up of casts of foraminifera. Clay, however, had been looked on, until the recent expeditions, as essentially a product of the disintegration of older rocks. Not only, however, are a large proportion of silicious and calcareous rocks either directly or indirectly derived from material which has once formed a portion of living organisms, but Sir Wyville Thomson maintains that this is the case with some clays also. In that case, the striking remark of Linnæus, that "fossils are not the children but the parents of rocks," will have received remarkable confirmation. I should have thought it, I confess, probable that these clays are, to a considerable extent, composed of volcanic dust.

It would appear that calcareous deposits resembling our chalk do not occur at a greater depth than 3,000 fathoms; they have not been met with in the abysses of the ocean. Here the bottom consists of

* I ought to mention that Darwin's views have recently been questioned by Semper and Murray.

exceedingly fine clay, sometimes colored red by oxide of iron, sometimes chocolate by manganese oxide, and containing with Foraminifera occasionally large numbers of siliceous Radiolaria. These strata seem to accumulate with extreme slowness: this is inferred from the comparative abundance of whales' bones and fishes' teeth, and from the presence of minute spherical particles, supposed by Mr. Murray to be of cosmic origin—in fact, to be the dust of meteorites, which in the course of ages have fallen on the ocean. Such particles no doubt occur over the whole surface of the earth, but on land they soon oxidize, and in shallow water they are covered up by other deposits. Another interesting result of recent deep-sea explorations has been to show that the depths of the ocean are no mere barren solitudes, as was until recent years confidently believed, but, on the contrary, present us many remarkable forms of life. We have, however, as yet but thrown here and there a ray of light down into the ocean abysses:

"Nor can so short a time sufficient be,
To fathom the vast depths of Nature's sea."

(*Concluded in the December number.*)

## THE DISCOVERY OF ORGANIC REMAINS IN METEORIC STONES.

By FRANCIS BIRGHAM.

THE great problem, whether or not other celestial bodies besides our own planet are or in past ages have been inhabited by animate beings, must be a subject of the deepest interest to every thinking being. This question has for some time past been answered in the affirmative with great probability. The complete analogy of physical conditions which has been proved to exist in some other planets of our solar system, and which without doubt must also occur in innumerable planets of other solar systems, allowed the very probable deduction that not only on our own earth a higher organic process of evolution has taken place. Still, this conclusion by analogy had hitherto remained a simple, unproved hypothesis, although supported by good evidence.

But now at last it seems that we have obtained a direct answer to this question, and that we are able to see with our own eyes the *veritable remains of animate beings from another celestial body.*

It has been conclusively demonstrated that the meteoric stones which from time to time drop down on the earth have at no time formed a part of this planet, and it is now generally conceded that they are the remains of other celestial bodies—probably those of a destroyed planet.

In such meteoric stones, and especially in the class called *chondrites*, on account of the peculiar spherical inclosures found in them, the eminent German geologist, Dr. Hahn, has recently discovered *an entire series of organic remains*. By a laborious process of grinding down and polishing these fragments he succeeded in producing a large number of thin laminæ or delicate stone shavings, which he subjected to a careful series of investigations under the most powerful microscopes. He has recently published a book on this subject, containing on thirty-two plates more than one hundred representations of these laminæ of meteorites, every one of which contains different forms and figures, which Dr. Hahn positively identifies *not as mineralogical* but as *organic*, and, in fact, *as zoölogical formations* belonging to the different classes of *sponges*, *corals*, and *crinoids*. These pictures, which have been reproduced from the original laminæ by photography, without any alterations or additions by a draughtsman, must cause great surprise to every geologist and paleontologist, who will at once recognize the structure of well-known coral types on several of the plates. The majority of the meteorites containing these forms are part of the celebrated great meteoric fall of Knyahinya in Hungary, which took place on the 9th of June, 1866.

Dr. Hahn, having sent the whole of his original shavings, comprising over three hundred specimens, to the noted zoölogist Dr. Weinland for examination and determination, the latter has also published a report on this subject in a German scientific journal, and the present article is based on the statements of these two scientists.

The result of a thorough examination of these specimens, with a complete comparison of his own great collection of corals, fully convinced Dr. Weinland that a large number of the formations in question are without doubt *remains of coral* belonging to the class of the *favositines*, which on the earth are now to be found only in a fossil state, and then only in the oldest, or palæolithic, stratum.

The terrestrial polypous branches of these favositines are composed of polypary tubes running parallel to each other. At the top, where the cups (*calyx*) open and the then living polyps are sitting, the coral branches of the favosite present a more or less regular *network*, composed of the walls of the different polyps. Besides, this class is especially characterized by the *cross-partitions* in the polypous tubes, as well as by the regular rows of minute holes in these walls, which facilitate the connection between each tube with its neighbors.

Now these polyparies (i. e., bundles of tubes entirely similar to those of the earth's favositines) can be found in a large number of Dr. Hahn's meteoric laminæ, which originated not from a single but from many separate falls of meteorites. Many of them show with perfect clearness the very same cross-partitions and rows of holes at fixed intervals from each other with so much regularity that it is impossible to admit a coincidence. At the same time, no geologist would attempt

to offer a mineralogical determination of these minute structures, partitions, and holes, which are already visible under a microscope magnifying two hundred times, but which may even still be traced *up to four hundred and eighty times.* It is, therefore, perfectly evident that the objects in question are organic remains, and, in fact, those of a class nearly related to our favosite corals.

Unfortunately, most of the laminæ are cut parallel to the length of the polypary tubes, because the huge meteoric stones had to be broken up in order to obtain these shavings, whereby they generally split with the length of the coral-branches. Only one remarkably fine lamina, a perfect unicorn, in the whole collection, and also a part of the fall at Knyahinya, affords a full view from the top of the branch into the calyx of the polyparium and into the arrangement of the cups themselves. This specimen alone must bring conviction to every connoisseur of corals. It is represented on Plate X, Figs. 3 and 4, of Dr. Hahn's book, but the yellowish tint of the lamina prevented the object from coming out as clearly on the photograph as it can be seen on the original under a good microscope.

This object is evidently a complete small coral-branch of roundish shape, which stands with a broad base on another coral formation. The whole network of the calyx can here be seen with the greatest clearness. The cups are quite dark in the center, being filled with a black substance ; then follows a whitish filling around this dark center, and then, plainly visible, the wall of each tube always as *a sharply defined line*, which is already visible with a low magnifying power. This network of lines, separating the single cups from each other, presents a variety of sizes and forms of the calyx, which, just like those of a great number of our corals, and especially of those of the Devonian *favosites polymorphus*, are very irregular, often larger or smaller than the average, with rounded or straight side-walls or smaller cups formed by the partition of one larger one. This ex-terrestrial coral has been named by Dr. Weinland, in honor of its discoverer, *Hahnia meteoritica.* All these coral structures in the meteorites are petrified, having taken the form of silicates of magnesia.

Another very notable peculiarity of these ex-terrestrial corals is *their extreme smallness*, for, in comparison with those of the earth's fauna, they represent *a veritable pygmy animal kingdom.* The just-described coral-branch of *Hahnia meteoritica* is but a white dot in the meteoric shaving, barely visible to the naked eye. Its greatest diameter measures but 0·90 millimetre, and the single cups average but 0·05 millimetre. These are dimensions quite unknown in any terrestrial corals, where a calyx of one millimetre diameter may already be called small. But we must still be prepared for yet quite different things in these ex-terrestrial organisms, for it is very possible that there may yet be found *formations for which we can absolutely find no place in our systems of zoölogy.* In fact, it is rather startling that the

above-mentioned structures present forms of coral so nearly related to those of the earth, and we must, therefore, accept this fact as important evidence that an organic evolution of great similarity to that on our own earth has taken place on whatever planet from which these meteorites originated.

Besides corals, Dr. Weinland has also succeeded in finding a number of other organic remains in Dr. Hahn's specimens. The material for this investigation was very large, for the greater part of the specimens has evidently been fused together from organic fragments. This is especially the case with the great meteoric stone of Knyahinya, which weighed over two hundred pounds. Well-preserved forms, however, are scarce, for the meteoric material was principally composed of fragments and detritus, which greatly resembled, for instance, the youngest marine chalk in the Gulf of Mexico. But, after comparing a great number of laminæ and attaining some practice in this work, Dr. Weinland succeeded in restoring certain often-repeated formations. The *sponges* especially were highly developed, and of these Dr. Weinland succeeded in actually determining three different genera. Of one characteristic bluish sponge, which occurred in several favorable shavings both as young and old specimens, he was able to make a drawing of its interior construction as easily as from a living specimen. He also thinks that he has discovered *vegetable traces;* at least, a remarkable, arched form, divided into two halves by a cross-partition, and measuring 0·8 millimetre in diameter, greatly resembles the shield-algæ (*cocconeis*). But he is yet unable to decide whether the formations, claimed by Dr. Hahn as *crinoids*, really belong to this class, for some of them are certainly *spongiæ*.

So far, not a single trace has been found of *higher animal forms* (*mollusca*, *arthrozoa*), but all the discovered organisms evidently indicate the *primary formation* of the celestial body from which they came. Then, again, this entire ex-terrestrial fauna hitherto discovered, which already comprises about fifty different species, and which originates from different meteoric falls, even from some during the last century, conveys the impression that it doubtlessly once formed part of *a single ex-terrestrial-celestial body* with a unique creation, which in bygone ages seems to have been overtaken by a grand catastrophe, during which it was broken up into fragments.

Perhaps some readers of this article will ask why this remarkable discovery has not been made before, considering the great number of meteorites already collected in our mineralogical collections and the considerable number of scientists who have investigated them.* Dif-

* Probably the largest collection of meteoric stones is in the possession of Mr. Shephard, of New Haven, Connecticut. It contains over 500 specimens, weighing together 1,200 pounds. The largest fragment, which weighs 436 pounds, comes from Colorado, and the smallest, of half an ounce only, from Otsego County, New York. The largest complete stone (56 pounds) fell in Muskingum County, Ohio, the smallest (less than 50

ferent circumstances will explain this question. Firstly, meteoric stones are always rare and costly objects, which are not easily sacrificed by their possessors, so that hitherto but very few of them have been broken up in order to obtain laminæ suitable for microscopic investigation. Then, again, the latter have only been manufactured in limited numbers, so that the probability of discovering a favorable object in them could consequently be but very small. Dr. Hahn, however, has made extraordinary sacrifices, both in time and money, to obtain his specimens, of which he now possesses no less than six hundred. It must also be mentioned that hitherto the investigations of a few specimens have been made with a magnifying-glass only, and but seldom with powerful microscopes, such as Dr. Hahn employs.

Besides thus affording positive proof of the fact that other worlds are or have been inhabited by organic beings, this important discovery has also solved another interesting problem, which has long perplexed the scientific world. By the newest theory of the celebrated astronomer Schiaparelli regarding meteorites, the latter were supposed to emanate from incandescent comets and their tails. Now all the petrified organisms discovered by Dr. Hahn have been proved to belong to *the subaqueous classes of animals*, and indeed have lived in water *which never froze entirely*, and for which we would certainly have to look in vain in comets, which are now generally admitted to be in a state of active combustion.

This affords but another proof of the transcendent importance of this new and great discovery, the general results of which we have now placed before the readers of this journal.

## THE AVAILABLE ENERGY OF NATURE.*

By Sir WILLIAM THOMSON.

DURING the fifty years' life of the British Association, the advancement of science, for which it has lived and worked so well, has not been more marked in any department than in one which belongs very decidedly to the Mathematical and Physical Section—the science of energy. The very name energy, though first used in its present sense by Dr. Thomas Young about the beginning of this century, has only come into use practically after the doctrine which defines it had,

grains) in Sweden. The specimens forming this collection have been brought together from all parts of the world, and belong to meteoric falls during several centuries. The first specimen in the catalogue fell on the 7th of November, 1492, in Alsace, and the last on the 12th of February, 1875, in Iowa.

* Opening address before Section A, at the York Meeting of the British Association for the Advancement of Science.

during the first half of the British Association's life, been raised from a mere formula of mathematical dynamics to the position it now holds of a principle pervading all nature and guiding the investigator in every field of science.

A little article, communicated to the Royal Society of Edinburgh a short time before the commencement of the epoch of energy, under the title "On the Sources available to Man for the Production of Mechanical Effect,"* contained the following:

"Men can obtain mechanical effect for their own purposes by working mechanically themselves, and directing other animals to work for them, or by using natural heat, the gravitation of descending solid masses, the natural motions of water and air, and the heat, or galvanic currents, or other mechanical effects produced by chemical combination, but in no other way at present known. Hence the stores from which mechanical effect may be drawn by man belong to one or other of the following classes:

"I. The food of animals.

"II. Natural heat.

"III. Solid matter found in elevated positions.

"IV. The natural motions of water and air.

"V. Natural combustibles (as wood, coal, coal-gas, oils, marsh-gas, diamond, native sulphur, native metals, meteoric iron).

"VI. Artificial combustibles (as smelted or electrically-deposited metals, hydrogen, phosphorus).

"In the present communication, known facts in natural history and physical science, with reference to the sources from which these stores have derived their mechanical energies, are adduced to establish the following general conclusions:

"1. *Heat radiated from the sun* (sunlight being included in this term) *is the principal source of mechanical effect available to man.*† From it is derived the whole mechanical effect obtained by means of animals working, water-wheels worked by rivers, steam-engines, galvanic engines, windmills, and the sails of ships.

"2. The motions of the earth, moon, and sun, and their mutual attractions, constitute an important source of available mechanical effect. From them all, but chiefly, no doubt, from the earth's motion of rotation, is derived the mechanical effect of water-wheels driven by the tides.

"3. The other known sources of mechanical effect available to man are either terrestrial—that is, belonging to the earth, and available without the influence of any external body—or meteoric—that is, belonging to bodies deposited on the earth from external space. Ter-

* Read at the Royal Society of Edinburgh, on February 2, 1852 ("Proceedings" of that date).

† A general conclusion equivalent to this was published by Sir John Herschel in 1833. See his "Astronomy," edition 1849, § 399.

restrial sources, including mountain quarries and mines, the heat of hot springs, and the combustion of native sulphur—perhaps, also, the combustion of inorganic native combustibles—are actually used; but the mechanical effect obtained from them is very inconsiderable, compared with that which is obtained from sources belonging to the two classes mentioned above. Meteoric sources, including only the heat of newly-fallen meteoric bodies, and the combustion of meteoric iron, need not be reckoned among those available to man for practical purposes."

Thus, we may summarize the natural sources of energy as tides, food, fuel, wind, and rain.

Among the practical sources of energy thus exhaustively enumerated, there is only one not derived from sun-heat—that is, the tides. Consider it first. I have called it *practical*, because tide-mills exist. But the places where they can work usefully are very rare, and the whole amount of work actually done by them is a drop to the ocean of work done by other motors. A tide of two metres' rise and fall, if we imagine it utilized to the utmost, by means of ideal water-wheels doing with perfect economy the whole work of filling and emptying a dock-basin in infinitely short times at the moments of high and low water, would give just one metre-ton per square metre of area. This work, done four times in the twenty-four hours, amounts to $\frac{1}{1616}$ of the work of a horse-power. Parenthetically, in explanation, I may say that the French metrical equivalent (to which, in all scientific and practical measurements, we are irresistibly drawn, notwithstanding a dense barrier of insular prejudice most detrimental to the islanders)—the French metrical equivalent of James Watt's "horse-power" of 550 foot-pounds per second, or 33,000 foot-pounds per minute, or nearly two million foot-pounds per hour, is seventy-five metre-kilogrammes per second, or four and a half metre-tons per minute, or two hundred and seventy metre-tons per hour. The French ton of one thousand kilogrammes, used in this reckoning, is 0·984 of the British ton.

Returning to the question of utilizing tidal energy, we find a dock area of 162,000 square metres (which is a little more than 400 metres square) required for 100 horse-power. This, considering the vast costliness of dock-construction, is obviously prohibitory of every scheme for economizing tidal energy by means of artificial dock-basins, however near to the ideal perfection might be the realized tide-mill, and however convenient and non-wasteful the accumulator—whether Faure's electric accumulator or other accumulators of energy hitherto invented or to be invented—which might be used to store up the energy yielded by the tide-mill during its short harvests about the times of high and low water, and to give it out when wanted at other times of the six hours. There may, however, be a dozen places possible in the world where it could be advantageous to build a sea-wall across the

mouth of a natural basin or estuary, and to utilize the tidal energy of filling it and emptying it by means of sluices and water-wheels. But, if *so* much could be done, it would in many cases take only a little more to keep the water out altogether, and make fertile land of the whole basin. Thus, we are led up to the interesting economical question, whether is forty acres (the British *agricultural* measure for the area of 162,000 square metres) or 100 horse-power more valuable. The annual cost of 100 horse-power, night and day, for 365 days of the year, obtained through steam from coals, may be about ten times the rental of forty acres at £2 or £3 per acre. But the value of land is essentially much more than its rental, and the rental of land is apt to be much more than £2 or £3 per acre in places where 100 horse-power could be taken with advantage from coal through steam. Thus, the question remains unsolved, with the possibility that in one place the answer may be *one hundred horse-power*, and in another *forty acres*. But, indeed, the question is hardly worth answering, considering the rarity of the cases, if they exist at all, where embankments for the utilization of tidal energy are practicable.

Turning, now, to sources of energy derived from sun-heat, let us take the wind first. When we look at the register of British shipping and see 40,000 vessels, of which about 10,000 are steamers and 30,000 sailing-ships, and when we think how vast an absolute amount of horse-power is developed by the engines of those steamers, and how considerable a proportion it forms of the whole horse-power taken from coal annually in the whole world at the present time, and when we consider the sailing-ships of other nations, which must be reckoned in the account, and throw in the little item of windmills, we find that, even in the present day of steam ascendency, old-fashioned wind still supplies a large part of all the energy used by man. But, however much we may regret the time when Hood's young lady, visiting the fens of Lincolnshire at Christmas, and writing to her dearest friend in London (both sixty years old now if they are alive), describes the delight of sitting in a bower and looking over the wintry plain, not desolate, because "windmills lend revolving animation to the scene," we can not shut our eyes to the fact of a lamentable decadence of wind-power. Is this decadence permanent, or may we hope that it is only temporary? The subterranean coal-stores of the world are becoming exhausted surely, and not slowly, and the price of coal is upward bound—upward bound on the whole, though no doubt it will have its ups and downs in the future as it has had in the past, and as must be the case in respect to every marketable commodity. When the coal is all burned, or long before it is all burned, when there is so little of it left, and the coal-mines from which that little is to be excavated are so distant and deep and hot that its price to the consumer is greatly higher than at present, it is most probable that windmills or wind-motors in some form will again be in the ascendant, and that

wind will do man's mechanical work, on land at least, in proportion comparable to its present doing of work at sea.

Even now it is not utterly chimerical to think of wind superseding coal in some places for a very important part of its present duty—that of giving light. Indeed, now that we have dynamos and Faure's accumulator, the little want to let the thing be done is cheap windmills. A Faure cell containing twenty kilogrammes of lead and minium, charged and employed to excite incandescent vacuum-lamps, has a light-giving capacity of sixty-candle hours (I have found considerably more in experiments made by myself, but I take sixty as a safe estimate). The charging may be done uninjuriously, and with good dynamical economy, in any time from six hours to twelve or more. The drawing-off of the charge for use may be done safely, but somewhat wastefully, in two hours, and very economically in any time of from five hours to a week or more. Calms do not last often longer than three or four days at a time. Suppose, then, that a five days' storage-capacity suffices (there may be a little steam-engine ready to be set to work at any time after a four-days' calm, or the user of the light may have a few candles or oil-lamps in reserve, and be satisfied with them when the wind fails for more than five days). One of the twenty kilogramme-cells, charged when the windmill works for five or six hours at any time, and left with its sixty candle-hours' capacity to be used six hours a day for five days, gives a two-candle light. Thus, thirty-two such accumulator-cells so used would give as much light as four burners of London sixteen-candle gas. The probable cost of dynamo and accumulator does not seem fatal to the plan, if the windmill could be had for something comparable with the prime cost of a steam-engine, capable of working at the same horse-power as the windmill when in good action. But windmills as hitherto made are very costly machines, and it does not seem probable that, without inventions not yet made, wind can be economically used to give light in any considerable class of cases, or to put energy into store for work of other kinds.

Consider, lastly, rain-power. When it is to be had in places where power is wanted for mills or factories of any kind, water-power is thoroughly appreciated. From time immemorial, water-motors have been made in large variety for utilizing rain-power in the various conditions in which it is presented, whether in rapidly-flowing rivers, in natural waterfalls, or stored at heights in natural lakes or artificial reservoirs. Improvements and fresh inventions of machines of this class still go on, and some of the finest principles of mathematical hydrodynamics have, in the lifetime of the British Association, and, to a considerable degree, with its assistance, been put in requisition for perfecting the theory of hydraulic mechanism, and extending its practical applications.

A first question occurs: Are we necessarily limited to such natural sources of water-power as are supplied by rain falling on hill-country,

or may we look to the collection of rain-water in tanks placed artificially at sufficient heights over flat country to supply motive power economically by driving water-wheels? To answer it: Suppose a height of one hundred metres, which is very large for any practical building, or for columns erected to support tanks; and suppose the annual rainfall to be three quarters of a metre (thirty inches). The annual yield of energy would be seventy-five metre-tons per square metre of the tank. Now, one horse-power for 365 times twenty-four hours is 236,500 foot-tons; and, therefore (dividing this by 75), we find 3,153 square metres as the area of our supposed tank, required for a continuous supply of one horse-power. The prime cost of any such structure, not to speak of the value of the land which it would cover, is utterly prohibitory of any such plan for utilizing the motive power of rain. We may or may not look forward hopefully to the time when windmills will again "lend revolving animation" to a dull, flat country; but we certainly need not be afraid that the scene will be marred by forests of iron columns taking the place of natural trees, and gigantic tanks overshadowing the fields and blackening the horizon.

To use rain-power economically on any considerable scale we must look to the natural drainage of hill-country and take the water where we find it either actually falling or stored up and ready to fall when a short artificial channel or pipe can be provided for it at moderate cost. The expense of aqueducts, or of underground water-pipes, to carry water to any great distance—any distance of more than a few miles or a few hundred yards—is much too great for economy when the yield to be provided for is *power;* and such works can only be undertaken when the *water itself* is what is wanted. Incidentally, in connection with the water-supply of towns, some part of the energy due to the head at which it is supplied may be used for power. There are, however, but few cases (I know of none except Greenock) in which the energy to spare over and above that devoted to bringing the water to where it is wanted, and causing it to flow fast enough for convenience at every opened tap in every house or factory, is enough to make it worth while to make arrangements for letting the water-power be used without wasting the water-substance. The cases in which water-power is taken from a town supply are generally very small, such as working the bellows of an organ, or "hair-brushing by machinery," and involve simply throwing away the used water. The cost of energy thus obtained must be something enormous in proportion to the actual quantity of the energy, and it is only the smallness of the quantity that allows the convenience of having it when wanted at any moment, to be so dearly bought.

For anything of great work by rain-power, the water-wheels must be in the very place where the water-supply with natural fall is found. Such places are generally far from great towns, and the time is not yet come when great towns grow by natural selection beside waterfalls,

for power, as they grow beside navigable rivers, for shipping. Thus, hitherto, the use of water-power has been confined chiefly to isolated factories which can be conveniently placed and economically worked in the neighborhood of natural waterfalls. But the splendid suggestion made about three years ago by Mr. Siemens in his presidential address to the Institution of Mechanical Engineers, that the power of Niagara might be utilized, by transmitting it electrically to great distances, has given quite a fresh departure for design in respect to economy of rain-power. From the time of Joule's experimental electro-magnetic engines developing ninety per cent. of the energy of a voltaic battery in the form of weights raised, and the theory of the electro-magnetic transmission of energy completed thirty years ago on the foundation afforded by the train of experimental and theoretical investigations by which he established his dynamical equivalent of heat in mechanical, electric, electro-chemical, chemical, electro-magnetic, and thermo-elastic phenomena, it had been known that potential energy from any available source can be transmitted electro-magnetically by means of an electric current through a wire, and directed to raise weights at a distance, with unlimitedly perfect economy. The first large-scale practical application of electro-magnetic machines was proposed by Holmes in 1854, to produce the electric light for lighthouses, and persevered in by him till he proved the availability of his machine to the satisfaction of the Trinity House and the delight of Faraday in trials at Blackwall in April, 1857, and it was applied to light the South Foreland Lighthouse on December 8, 1858. This gave the impulse to invention, by which the electro-magnetic machine has been brought from the physical laboratory into the province of engineering, and has sent back to the realm of pure science a beautiful discovery, that of the fundamental principle of the dynamo, made triply and independently, and as nearly as may be simultaneously, in 1867 by Dr. Werner Siemens, Mr. S. A. Varley, and Sir Charles Wheatstone—a discovery which constitutes an electro-magnetic analogue to the fundamental electrostatic principle of Nicholson's revolving doubler, resuscitated by Mr. C. F. Varley in his instrument "for generating electricity," patented in 1860; and by Holtz in his celebrated electric machine; and by myself in my "replenisher" for multiplying and maintaining charges in Leyden jars for heterostatic electrometers, and in the electrifier for the siphon of my recorder for submarine cables.

The dynamos of Gramme and Siemens, invented and made in the course of these fourteen years since the discovery of the fundamental principle, give now a ready means of realizing economically on a large scale for many important practical applications the old thermo-dynamics of Joule in electro-magnetism; and, what particularly concerns us now in connection with my present subject, they make it possible to transmit electro-magnetically the work of waterfalls through long, insulated conducting wires, and use it at distances of fifties or hun-

dreds of miles from the source, with excellent economy—better economy, indeed, in respect to proportion of energy used to energy dissipated than almost anything known in ordinary mechanics and hydraulics for distances of hundreds of yards instead of hundreds of miles.

In answer to questions put to me in May, 1879,* by the Parliamentary Committee on Electric Lighting, I gave a formula for calculating the amount of energy transmitted, and the amount dissipated by being converted into heat on the way, through an insulated copper conductor of any length, with any given electromotive force applied to produce the current. Taking Niagara as example, and with the idea of bringing its energy usefully to Montreal, Boston, New York, and Philadelphia, I calculated the formula for a distance of 300 British statute miles (which is greater than the distance of any of those four cities from Niagara, and is the radius of a circle covering a large and very important part of the United States and British North America), I found almost to my surprise that even with so great a distance to be provided for, the conditions are thoroughly practicable with good economy, all aspects of the case carefully considered. The formula itself will be the subject of a technical communication to Section A in the course of the meeting on which we are now entering. I therefore at present restrict myself to a slight statement of results:

1. Apply dynamos driven by Niagara to produce a difference of potential of 80,000 volts between a good earth connection and the near end of a solid copper wire of half an inch (1·27 centimetres) diameter, and 300 statute miles (483 kilometres) length.

2. Let resistance by driven dynamos doing work, or by electric lights, or, as I can now say, by a Faure battery taking in a charge, be applied to keep the remote end at a potential differing by 64,000 volts from a good earth-plate there.

3. The result will be a current of 240 webers through the wire taking energy from the Niagara end at the rate of 26,250 horse-power, losing 5,250 (or twenty per cent.) of this by the generation and dissipation of heat through the conductor and 21,000 horse-power (or eighty per cent. of the whole) on the recipients at the far end.

4. The elevation of temperature above the surrounding atmosphere, to allow the heat generated in it to escape by radiation and be carried away by convection is only about 20° centigrade; the wire being hung freely exposed to air like an ordinary telegraph-wire supported on posts.

5. The striking distance between flat metallic surfaces with difference of potentials of 80,000 volts (or 5,000 Daniell's) is (Thomson's "Electrostatics and Magnetism," § 340) only eighteen millimetres, and therefore there is no difficulty about the insulation.

* Printed in the "Parliamentary Blue-Book Reports of the Committee on Electric Lighting," 1879.

6. The cost of the copper wire, reckoned at eight pence per pound, is £37,000; the interest on which at five per cent. is £1,900 a year. If 5,250 horse-power at the Niagara end costs more than £1,900 a year, it would be better economy to put more copper into the conductor; if less, less. I say no more on this point at present, as the economy of copper for electric conduction will be the subject of a special communication to the section.

I shall only say, in conclusion, that one great difficulty in the way of economizing the electrical transmitting power to great distances (or even to moderate distances of a few kilometres) is now overcome by Faure's splendid invention. High potential, as Siemens, I believe, first pointed out, is the essential for good dynamical economy in the electric transmission of power. But what are we to do with 80,000 volts when we have them at the civilized end of the wire? Imagine a domestic servant going to dust an electric lamp with 80,000 volts on one of its metals! Nothing above 200 volts ought on any account ever to be admitted into a house or ship or other place where safeguards against accident can not be made absolutely and for ever trustworthy against all possibility of accident. In an electric workshop 80,000 volts is no more dangerous than a circular saw. Till I learned Faure's invention I could but think of step-down dynamos, at a main receiving-station, to take energy direct from the electric main with its 80,000 volts, and supply it by secondary 200 volt dynamos or 100 volt dynamos, through proper distributing wires, to the houses and factories and shops where it is to be used for electric lighting, and sewing-machines, and lathes, and lifts, or whatever other mechanism wants driving power. Now the thing is to be done much more economically, I hope, and certainly with much greater simplicity and regularity, by keeping a Faure battery of 40,000 cells always being charged direct from the electric main, and applying a methodical system of removing sets of fifty, and placing them on the town-supply circuits, while other sets of fifty are being regularly introduced into the great battery that is being charged, so as to keep its number always within fifty of the proper number, which would be about 40,000 if the potential at the emitting end of the main is 80,000 volts.

## THE DURATION OF HUMAN LIFE.

By M. DE SOLAVILLE.

CAN man reach and pass the age of a hundred years? is a question concerning which physiologists have different opinions. Buffon was the first one in France to raise the question of the extreme limit of human life. In his opinion, man, becoming adult at sixteen, ought

to live to six times that age, or to ninety-six years. Having been called upon to account for the phenomenal ages attributed by the Bible to the patriarchs, he risked the following as an explanation: "Before the flood, the earth was less solid, less compact, than it is now. The law of gravitation had acted for only a little time; the productions of the globe had less consistency, and the body of man, being more supple, was more susceptible of extension. Being able to grow for a longer time, it should, in consequence, live for a longer time than now."

The German Heusler has suggested on the same point that the ancients did not divide time as we do. Previous to the age of Abraham, the year, among some people of the East, was only three months, or a season; so that they had a year of spring, one of summer, one of fall, and one of winter. The year was extended so as to consist of eight months after Abraham, and of twelve months after Joseph. Voltaire rejected the longevity assigned to the patriarchs of the Bible, but accepted without question the stories of the great ages attained by some men in India, where, he says, "it is not rare to see old men of one hundred and twenty years." The eminent French physiologist, Flourens, fixing the complete development of man at twenty years, teaches that he should live five times as long as it takes him to become an adult. According to this author, the moment of a completed development may be recognized by the fact of the junction of the bones with their apophyses. This junction takes place in horses at five years, and the horse does not live beyond twenty-five years; with the ox, at four years, and it does not live over twenty years; with the cat at eighteen months, and that animal rarely lives over ten years. With man, it is effected at twenty years, and he only exceptionally lives beyond one hundred years. The same physiologist admits, however, that human life may be exceptionally prolonged under certain conditions of comfort, sobriety, freedom from care, regularity of habits, and observance of the rules of hygiene; and he terminates his interesting study of the last point ("De la Longévité humaine") with the aphorism, "Man kills himself rather than dies."

Another physiologist, Dr. Huferand, wrote in 1841 in the "Journal de la Société de Statistique universelle": "There is nothing to prevent our considering the most remote terms which the known examples of longevity offer to us as forming the extreme limit of human life, or as the ideal of perfection, as a model, finally, of what the nature of man is capable of under favorable circumstances. Experience attests that one may live to one hundred and fifty and even to one hundred and sixty years. More than this, the autopsy of Thomas Parr, who died at one hundred and fifty-two years, which showed that all his viscera were perfectly sound, proves that he might have lived still longer, if the new kind of life that he led in consequence of a change in his conditions of existence had not determined a mortal

plethora in him. There is, then, nothing improbable in the affirmation that the organization of man may endure and his vital force act during two centuries." Dr. Berthelot, adopting the doctrine that the duration of human life is proportioned to the time required for reaching maturity, cites as a well-known fact that the traveler Delahaye, who was born with a robust constitution and led a regular life, was not matured till long after the common time, married and became a father at seventy, and lived till he was a hundred and twenty years old.

The German physiologists have paid the greatest attention to this subject. Haller maintained that man might live to two hundred years. Hufeland, in his "Art of prolonging Life," teaches that the age of the world has to this day had no influence on the duration of human life, and that it may be prolonged to the length of the lives of the patriarchs computed according to the actual divisions of time; assuming that the animal lives eight times as long as it takes it to reach maturity, he calculates that man becoming an adult at twenty-five years, should live to be two hundred years old. This opinion is shared by Professor Karup, Dr. Buschner, of Darmstadt, and others who have written with reference to life insurance. Dr. Gardner, an English physiologist, has also published a work on the means of prolonging life, and has likewise adopted the doctrine of a ratio of the whole duration to the period required for full development. He believes, however, that the latter period is not fixed, but that it varies from eighteen to twenty-one years, and consequently the whole length of life should be between ninety and one hundred and five years. But he does not hesitate to affirm that the latter age has never been passed, if it has been reached. Sir George Cornewall Lewis is still more skeptical, and does not believe that the existence even of a centenarian can be demonstrated. Mr. J. Thomes, in "Notes and Queries," while he contests ultra-centenarianism as impossible, cites as entirely authentic the fact of a client of an English life-assurance company having died in 1879, at the proved age of one hundred and two years and some months. But this case, he adds, "is the only one which an open inquiry among the oldest life-assurance companies of England has brought to light." According to Mr. Thompson, however ("Curiosities of Longevity"), nothing decisive is involved in the extreme rarity of centenarians in the annals of insurance companies, for the highest ages are found in the lower classes of society, and notably among agriculturists, who do not insure their lives.

So far as to doctrines; we now come to examine the facts. In this we must exercise considerable restraint, for the data we have personally gathered and those which we have found in books, memoirs, medical dictionaries, etc., form a considerable collection, the reproduction of which would require a volume; we shall have to make a very limited choice from among the numerous documents.

The ancient Greek writers, especially Lucian, have left biographi-

cal notices concerning several centenarians of their country, and mention philosophers, moralists, poets, and artisans who reached and even passed one hundred years, among them the following: Solon, Thales, Pittacus, Epimedes, four of the seven wise men of Greece, lived more than a hundred years according to Lucian, who fixed the date of their death at about B. C. 600. Epimenides, poet and historian, according to Pliny, died at one hundred and fifty-four; Aristarchus, the tragic poet of Tegea in Arcadia, at one hundred years, about B. C. 460 (Lucian). The comic poet, Cratinus, of Athens, died at ninety-nine, B. C. 405. According to Valerius Maximus, Sophocles wrote his "Œdipus Tyrannus" when nearly a hundred years old, B. C. 405. The satirical poet Democritus died at one hundred and nine, B. C. 361; Gorgias, of Leontes, at one hundred and eight, B. C. 400. The great orator Isocrates perished from hunger at ninety-nine years, B. C. 338. Hippocrates, the father of medicine, died at the same age, B. C. 361. The philosopher Theophrastus died at one hundred and seven, about B. C. 254. Cleanthes, of Epirus, the celebrated disciple of Zeno, died nearly one hundred years old, B. C. 240. The historian, Hieronymus, of Rhodes, died at one hundred and four, B. C. 254. The immortal Galen died, like his great predecessor Hippocrates, almost a centenarian, B. C. 193. The philosopher Demonax, of Crete, perished from hunger at one hundred years, in the reign of Hadrian.

The Romans also had their centenarians, but the dates of their deaths are often not given. Juvenal was a hundred years old when he died, B. C. 120. Terentius Varro died at ninety-eight, B. C. 28. Quintus Fabius Maximus, augur for sixty-two years, died a centenarian, B. C. 107. Perennius Tutus died at Cornelia, at one hundred and eleven, A. D. 117.

Women also reached a very advanced age. It is notorious, for example, that Terentia, the divorced wife of Cicero, died at between one hundred and three and one hundred and twelve, after having been remarried three times, about B. C. 62. The poet Martial gives an epitaph in verse of a woman who died in his time at the fabulous age of two hundred years. The juggler Galeria practiced at her profession till she was a hundred years old, and died at one hundred and four, A. D. 9. According to Pliny, the comedian Luccia also played till the same age as Galeria, and died at one hundred and fifteen. Phlegon, in his book "De Rebus Mirabilibus" and "De Longævis," mentions the names and places of origin of one hundred and seventeen centenarians who died at different periods of the Roman Empire. On the taking of the census under Vespasian, A. D. 74, fifty-four of the inhabitants of the eighth administrative circumscription declared themselves to be one hundred years old, one hundred and fourteen between one hundred and one hundred and ten, two between one hundred and ten and one hundred and twenty-five, four between one hundred and twenty-five and one hundred and thirty, four between one hundred

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and thirty and one hundred and thirty-five, and three between one hundred and thirty-five and one hundred and forty. It is questionable whether these old persons may not have had some interest in claiming such great ages.

In modern times, we have for France documents relatively worthy of faith only from the beginning of the eighteenth century. Except in a small number of cases, where the ages have been authenticated by extracts from baptismal registers, these ages have no other guarantee of exactitude than the declarations of the interested parties and contemporaries.

Documents which we have before us—necessarily very incomplete—attribute to France, during the eighteenth century, a few more than a hundred centenarians. The majority of these were men, but women appear to have reached the most advanced ages. Agriculturists figure largely in the number, while industrial workers and inhabitants of cities are few among them. A certain degree of probability is given to the statements by the fact that the number of extraordinary ages claimed is very small. Instances of fecundity at advanced ages are not rare. Contemporaneous writers mention examples of rejuvenation which must be regarded as probably legendary, although they have been recorded without protestation in grave scientific works. A much more serious fact, and one that may be more reasonably admitted, is that of hereditary longevities, of which there are numerous examples. Most of these centenarians appear to have been temperate, only two instances of drunkards being known among them. Many of them were indefatigable walkers, traversing every day considerable distances to go to their work ; and, according to the custom of the day, they all went to bed and rose early.

Among the most distinguished of them were the following, whose cases are given in the order of their dates : The diplomat De Vignancourt died at one hundred and three, in the exercise of his functions ; the Marchioness of Luxemburg and the Maréchal d'Estrées died at one hundred ; the three advocates, Larroque, of Agen ; Coster, of Bordeaux ; and William Grévin, of Pont l'Eveque, the first two at a hundred and eleven, and the last at a hundred and seven. The master-saddler Philip Herbelot died in 1714, at the verified age of one hundred and fourteen years. M. Lefèbre de Lezeau still attended the councils of the king when a hundred years old, and died in 1715. Charles Colbert, brother of the great Minister, died at a hundred and four. Jacques Poncy, dean of the surgeons of Paris, performed operations in his hundredth year, and died at a hundred and two. The Count de Bethune, an old superior officer, died in Paris, at a hundred and five. Fontenelle died at a hundred, on the 9th of January, 1757. Dom Jean Mabillon, of the Academy of Inscriptions and Belles-Lettres, died in Paris at a hundred and six, in 1778. Anne Marie Brideau died at a hundred, in the enjoyment of a tontine fund that brought her 55,625

livres of revenue in return for an outlay of three hundred livres. The Marchioness of Balestrin died at a hundred years, famous for her wit and her satirical verses. Françoise Pinel, a pauper, died at the Charité in Lyons, at a hundred and four, in January, 1754; and Marie Nauserine, another pauper, at the Hospital of Dinan, at a hundred and five, in March, 1756. The Baron de Lavaur died in 1764, at a hundred and five. Madame Marie Jahan, widow of M. de Villeneuve, lieutenant-general, died at a hundred and eight. Madame Lullin, having reached a hundred years, received a bouquet with a complimentary verse from Voltaire. The most advanced age seems to have been attained by a patriarch of the Jura, named Jacob, who was presented to the National Assembly on the 28th of October, 1789, at the age, as attested by his baptismal record, of one hundred and twenty years. Two invalids, one a hundred and six, the other a hundred and seven years old, dined with the First Consul on the tenth anniversary of the capture of the Bastile, July 14, 1799. Facts concerning centenarianism are still more abundant in the nineteenth century, for more attention has been paid to collecting and publishing them, especially since the athenticity of such cases has been disputed. Dr. François de Beaupin, who died at Chateaubriand in 1805, a hundred and seventeen years old, was married a second time at eighty, and had sixteen children by each marriage. Dr. Dufournet, who died at Paris in 1810, aged a hundred and ten, married a girl of twenty-six at eighty, by whom he had two children. On the occasion of the inauguration of the equestrian statue of Louis XIV in 1822, Pierre Huet, who was called dean of the French army, and was a hundred and seventeen years old, was placed in a chair in front of the statue, and was decorated in the name of the King by the Prefect of the Seine. M. d'Ornois, of the Academy of Rouen, died at St. George's in 1834, at a hundred and five. Alexandre Mongeot, formerly Professor of Mathematics in the Polytechnic School, died at Passy in 1807, at a hundred and five, with all his faculties sound. Madame Foulon, sister of the unfortunate manufacturer of that name who was murdered by the populace in 1789, died in Paris at a hundred and four. A robust old man, M. Desquersonnières, formerly commissary of the armies, was still living in Paris in 1842 at the authenticated age of a hundred and fourteen years; we do not know the date of his death. We were personally acquainted with M. Verron, who died in 1860 at the well-authenticated age of a hundred years. He had administered the commune of Montmartre for more than fifty years, and was still its mayor at the time of his death. Baron de Posant, former prefect, died in Paris in 1872, at a hundred and two; the Count Jean Frédéric de Waldeck on the 29th of November, 1875, at a hundred years and some months. The latter was in his youth a military and diplomatic figure of considerable importance; he published a book of travels in North and South America in 1838, and was a painter of considerable distinction. M. Duroy, a retired officer,

being a hundred and four years old, attended the marriage of his great-granddaughters in 1877, sang, and opened the ball. M. Kennoux, Mayor of Plermeux-Gontier for fifty-three years, died in the same year at a hundred years and eight months. François Pelpel, a distiller of Paris, announced in the newspapers in 1878 that he had reached his one hundredth year, and was enjoying good health. Louis Etienne Mirvault, a former diplomat, who had served in the American war with Lafayette and Rochambeau, died at Ransay in the same year, aged a hundred and two years and six months. The celebrated physicist Becquerel was more than a hundred years old when he died.

Mr. Thompson, in his "Curiosities of Longevity," has related numerous cases of centenarianism in England. One of the most remarkable is that of a peasant who died near the middle of the seventeenth century at the hyperbolical age of one hundred and seventy-two years, and is said to have received the honor of being buried at Westminster. Another is that of Henry Jenkins, who is said to have lived to one hundred and seventy-five. Lord Bacon, of Verulam, in his book "De Vita et Morte," speaks of the deaths of contemporaries at the ages of one hundred and fifty and even of one hundred and sixty years, ages that were proved, he said, by judicial documents quite worthy of faith. The family of Thomas Parr, who died in his hundred and fifty-second year, incontestably enjoyed the privilege of a very great length of life. Parr left three grandsons, who died, one at one hundred and twenty-four, the second at one hundred and twenty-five, the third at one hundred and twenty-six years. William Parr died at Birmingham in 1770, one hundred and twenty years old, after having had forty-four children, grandchildren, and great-grandchildren die. John Tice died in 1770, after a troubled life of one hundred and twenty-six years. Mr. Thompson cites also, as entirely worthy of faith, the death of one Gordon at Edinburgh in 1775, at the age of one hundred and thirty-one years. According to Dr. Isidore Bourdon, Greenwich Hospital had in 1806 one hundred and twenty centenarians, thirteen of whom were bachelors. A man applied at a life-insurance office in London, in 1875, for insurance, who said, in answer to questions, that on his father's side his grandfather had died at one hundred and ten and his grandmother at ninety-five, and the same ancestors on the mother's side at one hundred and at ninety-nine years; his mother, still living, was one hundred and five, and his father had died at one hundred and eight. A man who presented himself at the police-office of Doncaster in 1872, said that he was one hundred and eight years old, and had had twenty-two children, and that his wife had died in 1870 at ninety-nine. The Rev. Mr. Bradon, of Southampton, was congratulated by the Queen on the occasion of his hundredth birthday in 1877. The Rev. James Hingham died at Unst in February, 1879, aged one hundred and three. He had learned Hebrew and German after he was ninety; his father died at one hundred and his grandfather at one hundred and five. It

would lengthen our list too much to quote from the records of centenarians in other countries. Taking the mean of the censuses from 1869 to 1872, we find that Europe (except Russia, Turkey, and a few small states in the south) had in a population of 212,940,376, 17,313,715 persons more than sixty, 79,850 more than ninety, and 3,108 more than one hundred years old; or one person in twelve over sixty, one in 2,669 over ninety, and one in 62,503 over a hundred. According to a table we have calculated for fifteen countries of Europe, more women than men attain an extreme old age, and the difference increases with the age. The greatest number of persons over sixty years of age is found in France, but not the greatest number of centenarians. Calculating upon the given age at death, we have found the percentage of those among the deceased who were ninety years old and more to be, in Great Britain, 9·73; in Sweden, 7·39; in France, 6·58; in Belgium; 6·07; in Switzerland, 6; in Holland, 4·47; in Italy, 3·76; in Bavaria, 3·42; in Prussia, 3·06; in Austria, 2·61.

As to whether the proportion of great longevities is increasing or diminishing, we have information only for France. During the fourteen years, from 1823 to 1837, the mean annual number of persons dying centenarians was 152, or one for 217,105 inhabitants; during the eight years, from 1852 to 1860, the mean was 111 in a population that had increased twenty per cent. But, although the great ages seem to have diminished, the mean length of life has very sensibly increased, and this is much better.

A number of centenarians have made their regimen known. Notwithstanding some rare examples to the contrary, temperance, sobriety, and regularity of habits, are of the first importance; then follow heredity, a relatively comfortable condition, freedom from strong and frequent emotions, residence as far as possible in the country, exercise, and a healthy and quiet business. The celebrated but humorous German physiologist, Hoffmann, summarizes the means of reaching a great age as follows: "Avoid excess in everything, respect old habits, even bad ones, breathe a pure air, adapt your food to your temperament, shun medicines and doctors, keep a quiet conscience, a gay heart, a contented mind."—*Revue Scientifique.*

## WORRY.

By Dr. J. MORTIMER GRANVILLE.

WHEN a strong and active mind breaks down suddenly, in the midst of business, it is worn out by worry rather than overwork. Brain-labor may be too severe, or ordinary exercise prolonged until it produces serious exhaustion; but the mere draining of re-

sources, however inexpedient, is not disease, and seldom inflicts permanent injury. A temporary collapse of the mental powers may be caused by excessive or too continuous exertion, just as a surface-well may be emptied by pumping it out more rapidly than it is refilled, but the apparatus is not thereby disorganized, and time will remedy the defect. When rest is not followed by recovery, the recuperative faculty itself, an integral part of the intellectual organism, must be impaired or disabled. This is not unfrequently the case when the possessor of a worried and weakened brain in vain seeks refuge from the supposed effects of "overwork" in simple idleness. Something more than exhaustion has occurred, and rest alone will not cure the evil. The faculty of repair is not in a condition to restore the equilibrium between potential energy and kinetic force. Divers hypotheses have been suggested to explain this state of matters. The mind has been compared to a muscle overstrained by a too violent effort, or paralyzed by excessive exertion. The two phenomena have little similarity, and no new light is thrown on the nature of mental collapse by the comparison. Perhaps a closer parallel might be found in the state which ensues when the tension of a muscular contraction is so high that spasm passes into rigidity, and molecular disorganization ensues. Meanwhile, however interesting these speculations may prove to the physiologist, they bring no relief to the sufferer. It is easy to see that a worse evil than simply using up his strength too rapidly has befallen him, but no one knows precisely *what* has happened. To cover the enigma, without solving it, "overwork" is taken to mean more than work *over* the normal, in quantity, quality, and time, but no attempt is made to determine how excess, in either or all of these particulars, can bring about the disability and decrepitude we bewail. It is to the investigation of this mystery that attention needs to be directed. If it should be possible to ascertain why a mind previously healthy, and still apparently intact, breaks down instantly and thoroughly under a strain not exceptionally great, and, collapse having once occurred, recovery follows tardily and is rarely complete, it will probably be within the scope of common-sense to draw some practical conclusions as to the prevention, and it may be the cure, of what is in truth becoming a scourge of mental industry already almost decimating the ranks of the army of progress, in every field of intellectual enterprise at home and abroad.

A certain degree of tension is indispensable to the easy and healthful discharge of mental functions. Like the national instrument of Scotland, the mind drones wofully and will discourse most dolorous music, unless an expansive and resilient force within supplies the basis of quickly responsive action. No good, great, or enduring work can be safely accomplished by brain-force without a reserve of strength sufficient to give buoyancy to the exercise, and, if I may so say, rhythm to the operations of the mind. Working at high-pressure may be bad,

but working at low-pressure is incomparably worse. As a matter of experience, a sense of weariness commonly precedes collapse from "overwork"; not mere bodily or nervous fatigue, but a more or less conscious distaste for the business in hand, or perhaps for some other subject of thought or anxiety which obtrudes itself. It is the offensive or irritating burden that breaks the back. Thoroughly agreeable employment, however engrossing, stimulates the recuperative faculty while it taxes the strength, and the supply of nerve-force seldom falls short of the demand. When a feeling of disgust or weariness is not experienced, this may be because the compelling sense of duty has crushed self out of thought. Nevertheless, if the will is not pleasurably excited, if it rules like a martinet without affection or interest, there is no *verve*, and, like a complex piece of machinery working with friction and heated bearings, the mind wears itself away and a breakdown ensues. Let us look a little closely at this matter.

The part which "a stock of energy" plays in brain-work can scarcely be exaggerated. Reserves are of high moment everywhere in the animal economy, and the reserve of mental force is in a practical sense more important than any other. It may happen that mere strength of mind carries a body with scarcely a vestige of power in reserve through some crisis of extraordinary difficulty, but the mental exploit is full of danger. The residual air in a lung is the basis of the respiratory process; the sustained tension of the smaller arteries transforms the pulsating current of blood thrown into the system by the heart to a continuous circulation; the equilibriated tonicity of opposing muscles gives stability to the apparatus of motion, and renders specific combinations of movement possible. What is true of the physical is also true of the mental constitution; the residual force, the tension, the tonicity, of mind, form the basis of intellectual action. It is not necessary to discuss the relations of mind and matter; even if the mental being is no more than a formulated expression of the physical organism, the continuity is so complete that the same laws govern both. For the purposes of the present argument it is sufficient to assert that, without a reserve of energy, healthy brain-work is impossible. Pain, hunger, anxiety, and a sense of mind-weariness, are the warning tokens of exhaustion extending to the reserves. When these indications are disregarded, or destroyed, as they may be, by stupefying drugs, an inordinate use of stimulants, a strong effort of the will, or the anæsthetic effect of excessive exhaustion, the consumption of energy goes on unobserved. The feats of intellectual or physical strength, the surprising exploits of special sensation and mind-power, performed by individuals under the influence of any condition which suspends the sense of pain, weakness, or fatigue, are explained by the circumstance that unsuspected reserves of power and endurance are placed at the disposal of the will. These resources were there before, but jealously guarded by the sensations. Martyrdom is possible under the influence of an over-

powering abstraction. Passion may produce a similar immunity from pain, and give ability to endure even self-inflicted injury. The daily experience of lunatic asylums will abundantly attest the truth of this last assertion.

How does all this bear upon the subject? It seems rather to strengthen the position assailed, by showing that "overwork" may exhaust the reserves, thereby arresting the function, and possibly destroying the integrity, of the mental organism! That is undoubtedly the surface view of the case, and it is the popular explanation of what occurs. To controvert the received hypothesis is the object of the present paper. The argument, opposed to the theory of work itself exhausting the stock of energy, may be simply stated thus: the reserves, physical and mental, are too closely guarded to be invaded by *direct* encroachment. Pain is not suspended by the persistent infliction of injury unless the mechanism of sensation is disabled or destroyed. Hunger does not cease until starvation has assailed the seat of nutrition. The sense of extreme weariness is not allayed by increased activity, but the longing for rest may subside, because it has been stifled by some overwhelming influence. The natural safeguards are so well fitted for their task that neither body nor mind is exposed to the peril of serious exhaustion so long as their functions are duly performed. In brief, overwork is *impossible* so long as the effort made is natural. When energy, of any kind, takes a morbid form of action, some force outside itself must be reacting upon it injuriously; and the seat of the injury, so far as the sinister influence on energy is concerned, will be found in close proximity to the sensation which under normal conditions guards the reserve. The use of stimulants in aid of work is, perhaps, one of the commonest forms of collateral influence suspending the warning sense of exhaustion. When the laborious worker, overcome with fatigue, "rouses" himself with alcohol, coffee, tea, or any other agent which may chance to suit him, he does not add a unit of force to his stock of energy, he simply narcotizes the sense of weariness, and, the guard being drugged, he appropriates the reserve. In like manner, when the dreamer and night-watcher, worn out by sleeplessness, employs opium, chloral, or some other poison to produce the semblance of repose, he stupefies the consciousness of unrest, but, except in cases where it is only a *habit* of sleeplessness, which has been contracted, and, being interrupted, may be broken by temporary recourse to a perilous artifice, the condition is unrelieved. Not unfrequently the warning sense is stifled by the very intensity of the motive power or impulse. Ambition, zeal, love, sometimes fear, will carry a man beyond the bounds set by nature. No matter what suspends the functions of the guard set at the threshold of the reserve, if the residual stock is touched, two consequences ensue—waste and depreciation. It is important to recognize both of these evils. The former is generally perceived, the latter is commonly overlooked. The

reserve, as we have seen, plays a double part in the economy: it is a stock in abeyance, and it is the base of every present act. Without a reserve of mental energy, the mind can no more continue the healthful exercise of its functions than a flabby muscle without tonicity can respond to the stimulus of strong volition and lift a heavy weight or strike a heavy blow.

The cause, or condition, which most commonly exposes the reserve of mental energy to loss and injury is *worry*. The tone and strength of mind are seriously impaired by its wearing influence, and, if it continue long enough, they will be destroyed. It sets the organism of thought and feeling vibrating with emotions which are not consonant with the natural liberation of energy in work. The whole machinery is thrown out of gear, and exercise, which would otherwise be pleasurable and innocuous, becomes painful and even destructive. It is easy to see how this must be. The longest note in music, the most steady and persistent ray of light—to use an old-fashioned expression—the tonic muscular contraction, are all, we know, produced by a rapid succession of minute motive impulses or acts, like the explosion and discharge of electricity from alternately connected and separated points in a circuit; in fact, a series of vibrations. Mental energy doubtless takes the same form of development. If a disturbing element is introduced by the obtrusion of some independent source of anxiety, or if, out of the business in hand, the mind makes a discord, confusion ensues, and for the time being harmonious action ceases. Working under these conditions in obedience to the will, the mental organism sustains injury which must be great, and may be lasting. The function of the warning sense is suspended; the reserve is no longer a stock in abeyance, and it ceases to give stability to the mind; the rhythm of the mental forces is interrupted; a crash is always impending, and too often sudden collapse occurs. The point to be made clear is this: overwork is barely possible, and seldom, if ever, happens, while the mind is acting in the way prescribed by its constitution, and in the normal modes of mental exercise. The moment, however, the natural rhythm of work is broken and discord ensues, the mind is like an engine with the safety-valve locked, the steam-gauge falsified, the governing apparatus out of gear; a breakdown may occur at any instant. The state pictured is one of worry, and the besetting peril is not depicted in too lurid colors. The victim of worry is ever on the verge of a catastrophe: if he escape, the marvel is not at his strength of intellect so much as his good fortune. Worry is disorder, however induced, and disorderly work is abhorred by the laws of nature, which leave it wholly without remedy. The energy employed in industry carried on under this condition is lavished in producing a small result, and speedily exhausted. The reserve comes into play very early in the task, and the faculty of recuperation is speedily arrested. Sometimes loss of appetite announces the cessation of nutrition; otherwise

the sense of hunger, present in the system, is for a time preternaturally acute, and marks the fact that the demand is occasioned by loss of power to appropriate, instead of any diminution of supply. The effort to work becomes daily more laborious, the task of fixing the attention grows increasingly difficult, thoughts wander, memory fails, the reasoning power is enfeebled; prejudice—the shade of defunct emotion or some past persuasion—takes the place of judgment; physical nerve or brain disturbance may supervene, and the crash will then come suddenly, unexpected by on-lookers, perhaps unperceived by the sufferer himself. This is the history of "worry," or disorder produced by mental disquietude and distraction, occasionally by physical disease.

The first practical inference to be deduced from these considerations is that brain-work in the midst of mental worry is carried on in the face of ceaseless peril. Unfortunately, work and worry are so closely connected in daily experience that they can not be wholly separated. Meanwhile the worry of work—that which grows out of the business in hand—is generally a needless though not always an avoidable evil. In a large proportion of instances this description of disorder is due to the lack of education in brain-work. Men and women, with minds capacious and powerful enough but untrained, attempt feats for which training is indispensable, and, being unprepared, they fail. The utilitarian policy of the age is gradually eliminating from the educationary system many of the special processes by which minds used to be developed. This is, in part at least, why cases of sudden collapse are more numerous now than in years gone by. It is not, as vanity suggests, that the brain-work of to-day is so much greater than that exacted from our predecessors, but we are less well prepared for its performance. The treatment of this form of affection, the break-down from the worry of work, must be preventive; the sole remedy is the reversal of a policy which substitutes results for processes, knowledge for education. It is a serious cause of discomfiture and sorrow in work that so much of the brain-power expended is necessarily devoted to the removal of extraneous causes of worry. Labor is so fatal to life, because it is so difficult to live. The deadly peril of work in the midst of worry must be confronted, because the disturbing cause can only be got rid of by persistent labor. This is the crux of the difficulty, and, in the attempt to cure the evil, the struggling mind finds its fate involved in a vicious circle of morbid reactions. Nevertheless, it is the fact that work in the teeth of worry is fraught with peril, and whenever it can be avoided it should be, let the sacrifice cost what it may.

The second deduction must be, that there is no excuse for idleness in the pretense of fear of "overwork." There is some reason to apprehend that the attention recently directed to this alleged cause of mental unsoundness has not been free from a mischievous influence on

minds only too ready to take refuge in any excuse for inactivity. If the private asylums of the country were searched for the victims of "overwork," they would nearly all be found to have fallen a prey to "worry," or to that degeneracy which results from lack of purpose in life and steady employment. This is a grave assertion, but it points to an evil it is especially needful to expose. Weak minds drift into dementia with wondrous celerity when they are not carried forward to some goal, it matters little what, by the impulse of a strong motive. The bugbear of "overwork" is, it may be feared, deterring parents and friends from enforcing the need of sedulous industry on the young. The pernicious system of "cram" slays its thousands, because *uneducated*, undeveloped, inelastic intellects are burdened and strained with information adroitly deposited in the memory, as an expert valet packs a portmanteau, with the articles likely to be first wanted on the top. Desultory occupation, mere play with objects of which the true interest is not appreciated, ruins a still larger number; while worry, that bane of brain-work and mental energy, counts its victims by tens of thousands, a holocaust of minds sacrificed to the demon of discord, the foe of happiness, of morality, of success. The enemy takes many shapes and assumes bewildering disguises. Sometimes he comes in like a flood, hurrying everything before him; with heaps of work to be done in less than adequate time. Now the victim is hurried from task to task with a celerity fatal to sanity. Then he is chained like a galley-slave to some uncongenial labor without respite. Again, a buzz of distracting and irritating mental annoyances seem let loose to distress and distract him. Under each and all of these guises it is *worry* that molests, and, unless he be rescued, will ruin him. Meanwhile, the miseries of "overwork," pure and simple, are few and comparatively insignificant. Those who bewail their infliction most loudly are weak of mind or torpid of brain. Of such lame and maimed mortals we are not now thinking. Their lot may be humiliating or pitiable, as their condition is due to neglect or misfortune; but our concern is with the multitude of strong and able-minded workers who fail at their task. These are the victims not of overwork but of worry, a foe more treacherous and merciless than all besides. The mind-cure for the malady to which "worry" gives rise, and from which so many suffer, is not idleness, or "rest," in the ordinary sense of that term, but orderly and persistent work. The work by which they have been injured has not been excessive, but bad of its kind and badly done. The palsied faculties must be strengthened and incited to healthy nutrition by new activity, at first, perhaps, administered in the form of passive mental movement, and then induced by appropriate stimuli applied to the mind.—*Nineteenth Century.*

# AMERICAN CLIMATE AND CHARACTER.

By EDWARD C. TOWNE.

THE statements given under this head at pages 705 and 706 of "The Popular Science Monthly" for September, 1880, are not borne out by a careful study of facts on English soil, where alone popular American and foreign ideas in regard to the English climate and character can be duly corrected. I have given special attention to the subject in the way of study for very many years, and in the way of observation in England during the past four years, and my conclusion is that the only English and American facts which present a contrast are exceptional ones, and that for the several statements of Mr. Young and the authorities quoted by him there is scarce any foundation at all. Study led me to the conviction long since that the general American or Yankee type, in all its varieties, belonged to England as truly as to America, and that the John Bull type is an exceptional one in England, and exclusively English, partly because it never emigrates, and partly because its characteristics are due to English eating and drinking habits. Observation has shown me that the facts are even more in this direction than I had expected to find them, and that statements such as those of Mr. Young and his authorities could hardly be more wide of the mark.

For more than thirty years I have had a habit of studying the looks of people upon every opportunity, and was most familiar when I came to England with American characteristics in Boston, New York, Philadelphia, Baltimore, Cincinnati, Chicago, and the Northern States generally, and to a considerable extent in the South. In England I have seen the crowds of London, Liverpool, Manchester, Sheffield, and other places, and have many times made a special study of large companies (one to four thousand) of people where I could walk about among them by the hour together. On one occasion, for example, I made a series of visits to a fair which brought together a large number of the titled ladies of the north of England. I saw there one lady of the type which made Hawthorne write as he did of the beef-eating bigness of English women—a duchess who must have frequently crossed Hawthorne's vision. The duke, her husband, reminded me of my own father, spare and dark, and no way a John Bull. The other ladies of quality had exactly the look in every way of the ladies one sees in the best company in Boston. The company generally, apart from the titled ladies, made no approach to a Boston company, but strikingly lacked quality, whether beauty, refinement, or taste. But there was no such contrast as Mr. Young asserts. There is no ground worth speaking of for his statement as to the contrast between English and American women. It is not at all true. I can compare a country vil-

lage in Massachusetts with one in Yorkshire, and what Mr. Young says of American women lacking or losing form and beauty is more true of the English example than the American. There are numbers of English women, it is true, who show the type, at one extreme, to which Mr. Young refers, but as you go from that extreme to the other you find the middle type as much the rule in England as in America, and the worn, thin, nervous type fully as common in England as in America, and often more extreme here than in America. It is life more than climate which produces this extreme, and life for Englishwomen is worse than American in the whole lower range of society, and in many sections higher up.

It is quite erroneous for Mr. Young to talk of the drying, irritating effect of American climate as compared with English. The drying, irritating, corrosive effect of the east wind in the streets of London is very much worse than anything known in America. It is a strong, steady Siberian wind, which blows for weeks together, with a biting power which I have seen entirely blacken the early leaves of the horse-chestnut. In many seasons, judging by what I have seen myself, and by many statements made by English writers, I should say that, in bad seasons at least, the irritating effects of the English climate are more than twice as bad as those of the American. At any rate, there is no ground whatever for saying that American women are made thin and English are not. More English women than American are made very thin by the greater cruelty to women of English care and toil and suffering. And, if more are kept stout, it is largely because the stout type have stuck to the home soil, and very largely because of beer added to beef.

Mr. Young's conclusion as to America, that "the dry air produces nervous, energetic, large-jointed skeletons, which have little or nothing in common with the stout, fresh, rosy, phlegmatic inhabitants of the mother-country," could not well be more wide of the mark. The type which Mr. Young says is American was produced hundreds of generations ago ; and if Mr. Young chooses he can see in the north of England a larger proportion of this type than he can find anywhere in America, except those parts of the South where English and Scotch of this type were numerous in the early colonies. Typical skeletons are not made in a day, nor in seven or eight generations. I should say that, across England by Manchester and Sheffield, the "nervous, energetic, large-jointed," not stout, not rosy, and most emphatically not phlegmatic men, are ten to one as numerous as anywhere in America. One supposes that he has seen nervous energy in Chicago, but only in England have I ever had my attention drawn to nervous energy almost gone mad. The impression that the English are phlegmatic is a false inference from peculiar appearances.

The exterior calm is very often that of suppressed temper, and the outbreak of violent temper is very much worse and much more fre-

quent in England than in America. It is common to find gentlemen, who are such in character and position, delightfully genial at one time and violently passionate at another. I met in America a gentleman of the best standing in his English home, the winning charm of whose manners awakened in me the desire to study character in the old country. One of my friends was dining with this gentleman after his return, and was asked, as an American, to state what the case was between the North and the South in the civil war. My friend made a moderate statement of his view as a Northern man, and, when he had concluded, his host, his face white and his lips trembling with passion, replied, "I have been several weeks in your country, in the North and in the South, and there isn't a word of truth in what you have said!" There was a second English gentleman present, who insisted that Mr. Garrison and other American friends had given the same account, and that it must be true. This second gentleman is physically what Mr. Young would call an American, and he has no more reserve of temper than the typical Boston gentleman.

Extreme passion is very much more common in England than in America, and especially in the north of England. But I doubt whether the very strong air and the intense vital vigor which it tends to produce explain it. It seems to me rather a moral survival, one of the signs of barbarism holding on which one so often encounters in England. The habit which many of the working-class have of brutally kicking their wives in the abdomen, and many other forms of British masculine energy, would disappear without reference to climate if education and other moral influences were such as they are in America.

Mr. Young singularly errs in stating that Britons have a stout, fresh, rosy habit, which they directly lose in American air. I am writing where there is a country population of four thousand, and I should make money by giving Mr. Young a dollar for every rosy Briton he could find if he would give me a cent each for every "peculiarly American" member of the population. In the towns, Mr. Young's Britons can be more easily found; but the type is more conspicuous than it is numerous. Of course, the style of dress, the cut of the beard, and the puff and color given to the face by drink, are not due to climate and are not race-characteristics; yet many not sufficiently instructed observers fail to see that, if they were to deduct these characteristics in the case of many who seem strikingly English, the type would look quite American. The last large company of Englishmen whom I have seen showed very many of the "nervous, energetic, large-jointed skeletons" of Mr. Young's peculiarly American type, and I have personal knowledge which enables me to say that nowhere in America could an equal number be found of men violently excitable and explosive. Temper, in fact, and nerves, are generally very much worse in England than in America. There is no approach in America

to the passion of an English crowd. A throng pressing to get at the doors of a public hall are violent and dangerous to a degree unknown in America. But it is the native barbarism, not the climate. In figure, stature, and aspect, a body of men in England met for intellectual purposes will rarely suggest any contrast between England and America. At the Royal Academy Exhibition in London on my first visit, when I studied the people rather than the pictures, and at the opening of the new Town Hall in Manchester, where four thousand people in full dress were wandering through the hall, corridors, and state apartments of the vast structure, the great mass of the people were not different from American in any of the respects named by Mr. Young. There is a marked difference, which an Englishman living in America expressed by saying that English women are dowdy compared with American. I should not say this, for it is not true; but it is true that, while cultivated and attractive refinement and taste are the same with women of the superior class in both countries, there is much less diffusion of the influence of this class in England than in America; and, so far from Mr. Young's view being true, it is rather the fact that a general crowd is much less good-looking in England than in America, and in no respect will American women suffer in comparison with English.

My first year in England took me over the region from London to Oxford, and I used every opportunity to observe both men and women, with the result that I hardly at all saw Mr. Young's British type. I did see it in a few gentlemen pampered with port and in farmers rosy with beer, but commonly I saw the American type, as Mr. Young would call it. In a society of thirty gentlemen with whom I met weekly, the type was much more American than it would have been in Plymouth, Massachusetts—figures slighter and temperament more nervous. The authorities quoted by Mr. Young have spoken much more from hasty theory than from any real facts. Dr. Reich has no warrant whatever for asserting a great difference between English and American physical types. The differences are not so much physical as moral, and they are not, with some exceptions, so much differences of type as differences superficially established by habits. If England had had American education and abstinence for the past fifty years, and could learn freedom, equality, and humanity as Americans do, it would be hard to see any great difference between the two peoples. What Dr. Reich says of the dryness and heat of America is said ignorantly. Is American air so dry along the Atlantic coast, and within reach of the great line of Northern lakes? The truth is, not that America is too dry, but that England is often not dry enough, and at other times is more dry than America. Dr. Reclam is out of sight of the facts completely when he compares the air of America and its effects to those of heights where lightness and dryness prevail, and thinks Americans characterized by peculiarities such as in Europe

he supposes due to the dry northeast wind. This wind, from which England and the Continent suffer so much, is very much worse than any wind known to that chief part of America which extends from the Atlantic to the far side of the Mississippi Valley; and, so far as it produces results in exaggerated nervous activity and excesses of the national character, England and Germany are much worse off than America. In England especially, exaggerated nervous activity and excesses of national character are very much worse than they are in America, and, if northeast wind really causes such things, the atrocious blast certainly rages across England as it never does in America. What Matthew Arnold calls the effusion and the confusion and the vulgarity of the middle-class Englishman, that is, of the average Englishman, is something very much worse than any American development, and, so far as climate plays upon and excites this, England has ten days of irritating rawness, dryness of cold wind, and poison of dust, to one that America has.

As for heat, the mistake is no less complete. England suffers more from 78° than America from 98°. There is never a chance to change to summer dress with any security, and heat, when it does come, has to be undergone without preparation. It commonly, moreover, comes with excess of moisture, and has an effect more dangerous than twenty degrees more of American heat. Dr. von Pettenkofer has not done wisely in comparing the case of a person living in dry air with that of one living in damp air. Americans do not live in dry air, and Englishmen, with excess of damp much of the time, do not develop fat, or phlegmatically nervous temperament, or a sluggish want of intense energy. The mad chase after the material things of the world is more mad and feverish and violent in Manchester and its cotton-spinning neighbors than it is in Chicago and the Northwest of America. I think circumstances and not climate chiefly explain it, but for climate the American is much less likely than the English to produce the effect. The European hygienists, who are dealing with the subject by means of speculative observations, ought to try a winter and spring in Oldham, Blackburn, Bolton, or Wigan, and see what a cold wind can do, with dust and coal-smut, to create dry torment, and to sting the bony, skinny, fierce operative into communistic madness. If they would study a Lancashire mob and an English east wind, and would read the tale of speculation, fierce competition, and fraud in manufacture, which the Manchester men know so well, there would be an end of the shallow philosophy into which a totally wrong report of the facts has betrayed them.

Dr. Büchner could not have gone more astray than in his astonishing conclusion that Americans are tending toward the Indian type, not only in the face and form, but in the gestures and movements. The inference can not rest with Dr. Büchner on any adequate observation, either of Indians or of Americans, and its extravagance is wild

and ridiculous in any just view of the real facts. It does not follow that gestures and movements, due to, we will say, acute tactical sensitiveness, indicate community of race. Some which I have had myself, I remark in my English housekeeper, and no doubt I might see them in an Indian or a negro. But one decisive fact disposes of Dr. Büchner's inference. The English much oftener suggest the Indian type than the Americans do, and there is much less extravagance in imagining, baseless as the notion would be, that England is turning Indian than in supposing that America shows such a tendency. In America I never saw a markedly Indian type without Indian blood, but I have seen it in England again and again ; in one case a lady with the dirty-black skin, straight, intensely black hair, high, fierce temper, indifference to grime and smut on her hands, and habitually very bad breath of a savage, and yet purely English, and as much a lady and a Christian as her peculiarities permitted. America is much further than England from the Indian type, and is not tending toward it, but the contrary. In the earliest American days the opinion was at one time general in England that the climate of Virginia turned the colonists into blacks, and that, besides going black, a man was there harnessed into the plow and the cart and made to do the work of a beast. The like notions, only not quite so outrageous, form now a large part of English and foreign supposed knowledge of America, and Dr. Büchner's notion that Americans tend toward the Indian type is about the worst item of this *pseudo*-knowledge. English ignorance about America seems to me the worst ignorance anywhere existing. It is largely due to the greed of the general English mind for mean ideas of America. Unfortunately, many Americans unwittingly feed this greed, either from lacking correct comparative knowledge of England and America, or from making assertions or admissions which will be entirely misunderstood by the English mind. It requires a good deal of varied residence and reading for an American to know accurately and adequately his own country, and to know it in comparison with England requires residence in England, and that among the people. The most rural parts of England are best for knowledge calculated to throw light on America. The peculiar Yankee characteristics, as of guessing and questioning and cute getting to know all about a person or matter, I have actually seen in England, in their native seats. They are all old rural English, and have nothing to do with either climate or character in America. In America they have dwindled and been effaced more than they have in England.

But what I would particularly emphasize is the twofold fact that the character and the climate which are said to be American are both English a good deal more than they are American. The nervous temperament ; the excess of energy ; the exaggerations and intensities of character ; the vulgarities and madness of selfish getting ; the fierce resort to sham and shoddy as a short cut to profit ; and all the forms

of headlong service of the devil to which unregenerate, raw, brute humanity can be tempted, are very much worse in England than they are in America. And the air said to favor such characters is much more found in England than in America. I was myself under the impression, before I lived in England, that we had in America more electrical excitement than is known in England. But now I find that it shuts down on you more in England, and that while you see more in America, at a great height above the earth, you feel more of it in England, and have it dropping on you more; and that, although the climate is characteristically damp, there occur more and longer times of irritating dryness and electrical aggravation than are known in America. I am fortunately able to cite a testimony which will make clear what I mean, and prove that I do not imagine my facts. In "Nature" for September 9th, page 437, Professor Tait quotes from an account given him by an Irish correspondent, who tells how the dryness I speak of may come out of the same quarter from which at other times moist air comes, and who expressly says that the same dryness comes with the east wind which is such a curse to the British Isles. Professor Tait's correspondent wrote as follows:

"At the commencement of the present unprecedentedly long and severe storm the wind blew from southwest, and was very warm. After blowing about two days it became, without change of direction, exceedingly bitter and cold, and the rain was from time to time mixed with sleet and hail, and lightning was occasional. This special weather is common for weeks together in March or early April. The air is (like what an east wind brings in Edinburgh) cold, raw, dry, and in every way uncomfortable, especially to people accustomed to the moist Atlantic winds. During these weeks a series of small clouds seem to start at regular intervals from the peaks of hills in Connemara and Mayo. They are all more or less charged with electricity. I have at one time seen such a cloud break into lightning over the spire of the Jesuits' church. At another, I have seen such a cloud pour down in a thin line of fire, and fall into the bay in the shape of a small, incandescent ball. On one occasion I was walking with a friend, when I remarked: 'Let us turn and make a run for it. We have walked unwittingly right underneath a little thunder-cloud.' I had scarcely spoken, when a something flashed on the stony ground at our very feet, a tremendous crash pealed over our heads, and the smell of sulphur was unmistakable."

This sort of greater nearness of the electrical demonstrations is the rule in Great Britain; and the horrid dryness, rawness, and aggravation spoken of in the above account, as due to the east wind when that blows, as it does for weeks together, and also due for weeks together to other wind, are a greater and a more grievous infliction in Great Britain than anything known in America over the chief settled region.

I think the general facts in regard to the English race in England and America and elsewhere should be referred to a history going back, not for the seven American generations, nor even for the forty British generations, but for at least a thousand generations. This great race, whose tongue is now spoken by a quarter of civilized mankind, was not made yesterday, and will not be unmade to-morrow. Its great essential lines are precisely the same in England and in America. New England in America was settled by English of picked moral and intellectual quality, and with the enormous double advantage of freedom to educate everybody and give everybody a chance, and of entire absence of the vile, pauper, and prostitute class which Old-World circumstances had created. The result has been that America, without some superlative advantages possessed by England, has on the broad level done more and done better than England in the direction of mind and quality, character and achievement—truly English in the higher sense of race; and that the British English type mainly differs from the American English by backward relation to barbarism, the Old-World use of war, monarchy and aristocracy, privilege oppressive of the people, as of lords and landlords, priests, pensioners, and publicans, and other forms of grievous denial of the rights and injury to the welfare of man as man. It would take a volume to tell the story of English barbarism. The English race has won on American soil stages of advance not yet won in England; and, when all the facts are discriminated, it will appear that climate in America is anything but unfavorable to this advance, although the opinion is a superficial error that climate has much to do with character in an age when circumstances dominate in the environment of a highly civilized race. As soon as English circumstances overtake American, there will cease to be any marked difference between the English in England and the English in America. And, when verified knowledge shall take the place of speculative, there will be no more Americo-German attempts to describe American climate as dry and damaging as compared with English. The climate of America is as much better than that of England as American civilization is more advanced on the broad level of the common people. It would double the value of England in every respect to have the climate of America. And certainly character would gain more than it would lose by the change.

# SKETCH OF GEORGE JARVIS BRUSH.

By Professor T. R. LOUNSBURY.

PROFESSOR GEORGE J. BRUSH was born in Brooklyn, New York, on the 15th of December, 1831. His father was a merchant in that city, but in 1835, retiring from business, took up his residence in Danbury, Connecticut. There the family remained till 1841, when they returned to Brooklyn; and in the schools of these two places Mr. Brush received his early education. It was not, however, until 1846, when he was sent to a school in West Cornwall, Connecticut, that he had an opportunity to pay any special attention to science. This school was kept by Mr. Theodore S. Gold, who was an enthusiastic student of mineralogy, botany, and of various other departments of natural history; and he not only gave instructions to his pupils in these subjects, but succeeded in inspiring them with a taste for them. Although young Brush was at this place only six months, he remained long enough to acquire a fondness for natural science, which in the end resulted in changing his course in life. He intended to pursue a business career; and, accordingly, on leaving the school at West Cornwall, entered, in the latter part of 1846, the counting-house of a merchant in Maiden Lane, New York City. There he remained for nearly two years, but the taste for scientific study already acquired did not desert him, and, in particular, he took advantage of every opportunity that came in his way to go off upon mineralogical excursions. A severe illness that befell him in 1848 rendered it necessary that he should abandon the mercantile profession, and it was decided that he should take up in its place the life of a farmer.

Just about this time Professor John P. Norton returned from Germany, and in conjunction with Professor Silliman, Jr., opened at Yale College a laboratory for the purpose of practical instruction in the applications of science to the arts and to agriculture. At the same time he began a course of lectures on agriculture and agricultural chemistry. To attend these lectures, to fit himself as thoroughly as possible for the life of a farmer, Professor Brush, not as yet seventeen years old, repaired to New Haven in October, 1848. This event changed his career. He came to attend a single course of lectures on agriculture. He remained two years as a student of chemistry and mineralogy. In October, 1850, he went to Louisville, Kentucky, as assistant to Benjamin Silliman, Jr., who had been elected Professor of Chemistry in the university of that city. There he remained the following winter, and in March, 1851, made one of the party who accompanied the elder Silliman on a somewhat extended tour in Eu-

rope. Returning to Louisville in the autumn of that year, he continued acting in his old capacity until the spring of 1852. Then he returned to New Haven. At the time he was a student, no degrees were granted by the college merely for proficiency in science. There was a general feeling that the pursuit of it, like the pursuit of virtue, was its own reward. But through the exertions of Professor Norton the corporation of the college voted to create the degree of Bachelor of Philosophy, and to grant it to those of the old students in the department of science who would come back and pass a satisfactory examination. Accordingly, Mr. Brush returned, and, after undergoing examination, received, with six others, at the commencement of 1852, the degree of Ph. B., the first time it was given by the college.

The academic year 1852–'53 was now spent by him at the University of Virginia, where he was employed as assistant in the chemical department. Here he was associated with Professor J. Lawrence Smith in a series of special studies, the object of which was to reëxamine a number of American minerals which had been described as new species. The results of their joint investigations were published in the fifteenth and sixteenth volumes of the "American Journal of Science," second series. At the end of the academic year Professor Brush went to New York, where he was associated with Professor Silliman, Jr., in charge of the mining and mineral departments of the Universal Exposition held that year in the city. But he now began to feel the necessity of pursuing his studies to an extent which he was not able to do in this country, especially at that time. Accordingly, in 1853, he sailed for Europe, and, during one year at the University of Munich, devoted himself to chemistry and mineralogy under Liebig, Von Kobell, and Pettenkofer. The year following—that of 1854–'55—he spent at the Royal Mining Academy in Freiburg, Saxony.

Just about this time an effort was being made at New Haven to put the scientific department of Yale College in a more satisfactory position than it had previously held. To the building of it up Professor Norton had sacrificed time and money, and, at last, his life; and, after the loss it sustained in his early death, it for a while continued to exist rather than to live. Outside of a very small circle, nobody cared for it, and it might at any moment have dropped entirely out of being, and the larger portion of the academic world would not have known enough of it even to regret its death. Modern science is so aggressive, it occupies so prominent a position both in the theory and practice of education, that it is hard for us now to realize how low was the estimation in which it was held in this country, even less than thirty years ago. The academic department of Yale College numbered at that period among its faculty the names of some men of science who were held in honor throughout the country. Their reputation, in fact, rather overshadowed that of most of their colleagues in other branches. Still, so strong was the influence of ancient tradition, that the prevail-

ing college sentiment reflected the views and feelings of the past, and very little those of the present; it did not begin to have even a conception of what was in store in the future. The student might or might not learn Latin and Greek; but, whichever was the case, he left the institution with a profound respect for them both, and usually the degree of his respect was fairly proportioned to the degree of his ignorance. It was not at all so in the case of the natural sciences, in spite of the eminence of some of its professors. Nor in the academic body as a whole was there then the least comprehension of what may be termed the solidarity of studies—that community of honor and dishonor in which they share, which renders it impossible for any one of them to be unduly depreciated without having some injurious effect upon the development of all the rest.

Still, the necessity of doing something more than had been done was beginning to be felt; and in a feeble way efforts were put forth to prepare for what the blindest could not fail to see was the inevitable. In 1854 an attempt was made at organization. The scattered instruction given by individual professors was brought together in the catalogue, though nowhere else; and an institution under the somewhat imposing name of the Yale Scientific School existed at least on paper. There was then no money with which to endow it; it is safe to say that, had there been, none would have been voted. But in one respect the corporation did a service to the new department they had created greater than could have been rendered by any pecuniary assistance that lay in their power. At the commencement of 1855 they elected Mr. Brush to a professorship.

He was first offered the chair of mining and metallurgy; but this he declined as embracing too much, and the title was limited to that of metallurgy alone. This, several years after, was exchanged for that of mineralogy. To qualify himself still further for the position, the newly-elected Professor went, in the autumn of 1855, to London, where he pursued his studies in the Royal School of Mines. The following year he made an extended tour through the mines and smelting-works of England, Scotland, Wales, Belgium, Germany, and Austria. In December, 1856, he returned to this country, and, in January, 1857, he entered upon the duties of his professorship.

From this time on the history of Professor Brush has been the history of the special scientific department of Yale College, which, in 1860, owing to the liberal benefactions of Mr. Joseph E. Sheffield, received the name of the Sheffield Scientific School. He came to it while it was not only without reputation, but without appreciation or expectation. He came to it while it was poor beyond even that decent poverty which apparently belongs, in the nature of things, to institutions of learning—while it was in a state so unorganized that as a whole it could hardly be said to have a being at all. It exhibited, indeed, a good deal of life in the college catalogue, but beyond that

its vitality did not extend. There was vigor enough in certain of its departments, especially in that of civil engineering, under the charge of Professor William A. Norton; but in such cases it was a vigor due to the energy of the individual instructor, and therefore almost certain to disappear whenever he disappeared. To bring these scattered units into an organic whole, to build up a complete and consistent scheme of scientific education, which should have both definite and lofty aims, which should train men thoroughly in scientific methods, and which should continue to exist by its own inherent vitality after the men who established it should have passed away—all this became by degrees a main work of Professor Brush's life. His energy, his judgment, his executive capacity, and his devotion, soon gave him the leading direction in the affairs of the institution. He was for a long period its secretary; he has always been its treasurer; and when, in 1872, a more formal organization of its faculty was felt to be desirable, he was elected as its presiding officer, a position which he still retains. Others have done their part toward developing various departments of the school, but its growth, as a whole, the position which it has acquired among scientific institutions, whatever that position may be, has been due to him very much more than to any other one man connected with it. None are more willing to admit this than the colleagues who have coöperated with him; and it is a gratification for them to have an opportunity of saying here, without his knowledge, what would never be suffered to be printed were it submitted to his inspection.

Nor has Professor Brush been idle in his special work, in spite of the exhausting demands made upon his time and thought by the management of the Sheffield Scientific School. The series of investigations made by him on American minerals, in conjunction with Professor J. Lawrence Smith, has already been mentioned. He coöperated with Professor Dana in the preparation of the fifth edition of his treatise on "Descriptive Mineralogy," published in 1868, and an account of his special services in connection with that work will be found stated in the author's preface. To the two editions preceding, as well as to this one, he contributed analyses of minerals. He also edited the eighth, ninth, and tenth supplements to this fifth edition, as well as the appendix to it published in 1872. In 1875 he brought out also a "Manual of Determinative Mineralogy and Blowpipe Analysis." In addition to these he has been a constant contributor to the "American Journal of Science," as will be seen by the following list of articles furnished by him to that periodical:

*Second Series.*

Vol. x, p. 370: "Analyses of American Spodumene."

Vol. xviii, p. 407: "On the Chemical Composition of Clintonite (Seybertite)"; p. 415: "On a new test for Zirconia."

Vol. xx, p. 273: "On Prosopite."

Vol. xxiv, p. 128: "On the Chemical Composition of Antigorite"; p. 116: "On Dechenite and Eusynchite"; p. 124: "Note on Parathorite."

Vol. xxv, p. 198: "Chemical Composition of Chalcodite."

Vol. xxvi, p. 64: "Analyses of Gieseckite (?) from Diana, Compact Pyrophillite, Unionite, Danbury Feldspar."

Vol. xxvii, p. 395: "Chemical Examination of Boltonite."

Vol. xxxii, p. 94: "On Crystalline Hydrate of Magnesia."

Vol. xxxiv, p. 243: "On Amblygonite from Maine"; p. 402: "On Triphyline from Norwich, Massachusetts."

Vol. xxxvi, pp. 122, 257: "On Childrenite from Hebron, Maine"; p. 152: "On the Tucson Meteoric Iron."

Vol. xxxvii, p. 66: "On Tephroite."

Vol. xxxix, p. 132: "On Artificial Diopside."

Vol. xli, p. 246: "On Cookeite and Jefferisite."

Vol. xliv, p. 249: "On Native Hydrates of Iron."

Vol. xlvi, pp. 140, 240: "On Sussexite."

Vol. xlviii, p. 17: "On Hortonolite"; p. 17: "On Durangite"; p. 179: "On a Meteoric Stone from Frankfort, Alabama"; p. 360: "On Magnetite in the Pennsville Mica."

*Third Series.*

Vol. i, p. 28: "On Gahnite from New Jersey."

Vol. ii, p. 30: "On Ralstonite."

Vol. v, p. 421: "On Compact Anglesite."

Vol. xi, p. 464: "On Durangite."

Vol. xxi, p. 312: "On American Sulposelenides of Mercury."

In 1878 a new and remarkable mineral locality at Branchville, Fairfield County, Connecticut, was discovered; and, in connection with Professor Edward S. Dana, Professor Brush produced a series of papers on the new minerals there found. These papers are contained in the "American Journal of Science," third series, vol. xv, pp. 398, 481; vol. xvi, pp. 33, 114; vol. xvii, p. 359; vol. xviii, p. 45, and vol. xix, p. 316; and in them are described the new phosphates—Eosphorite, Triploidite, Dickinsonite, Lithiophilite, Reddingite, Fairfieldite, and Fillowite. In conjunction also with Professor E. S. Dana he contributed to the same journal a memoir on "Spodumene and its Alterations" (xx, 257), and a paper on "Crystallized Danburite from Russell, New York" (xxi).

In 1862 Professor Brush was made a corresponding member of the Royal Bavarian Academy of Sciences; in 1866 a member of the Imperial Mineralogical Society of St. Petersburg; and in 1877 a foreign correspondent of the Geological Society of London. He is also a member of the American Philosophical Society, of the National Academy of Sciences, and of various other scientific bodies in this country. In 1880, at the meeting of the American Association for the Advancement of Science, held at Boston, he was elected its president for the following year, and in that capacity presided over the meeting held in August, 1881, at Cincinnati.

# CORRESPONDENCE.

## THE COPPER-MINES OF ISLE ROYALE.

*Messrs. Editors.*

I HAVE read with much pleasure Professor Winchell's paper on the "Ancient Copper-Mines of Isle Royale," in "The Popular Science Monthly" for September. As the Professor's very laudable object is undoubtedly "to make a little history" respecting the wonderful copper-mines of Lake Superior, and as no narrative (with the exception of some occasional geological reports) respecting the late working of them has to my knowledge been published, and as he has inadvertently made some quite important omissions, with your leave I will endeavor to supply the deficiency. On page 602 he says: "The finding of these thin chips of copper is the first indication of the proximity of a large mass. In the summer of 1874 the first of these large masses was discovered."

In the summer of 1822, fifty-two years *before* "the summer of 1874," General Cass, at that time the United States Territorial Governor of what now constitutes the States of Michigan, Wisconsin, and Minnesota, and *ex-officio* Superintendent of Indian Affairs for the Northwest, made his celebrated trip from Detroit to the head of Lake Superior, with his party, "in birchen canoes," and thence overland to the Mississippi River. He stopped at the mouth of the Ontonagon River, on the south shore of Lake Superior, two or three days to recruit his *voyageurs* after a "canoe-paddle" of nearly one thousand miles from Detroit. Knowing what the "early Jesuits" had said about copper in that country, in the published memoirs of their operations in the "Great Lake country," nearly two hundred years before, he naturally sought information of the Indians he found there respecting it. They took him to a mass of copper which was lying on the bank of the Ontonagon River, some eight miles from its mouth. It was found to be, apparently, *pure native copper*. In 1845, I think it was, *Julius Eldred*, of Detroit, by permission of the Government, took it to Washington, for the purpose of its being eventually put into the Washington Monument, as a contribution showing the mineral resources of Michigan. It weighed something like six thousand pounds. In 1848 the Minnesota Mining Company commenced work on their mine, in the range of hills some twenty-one miles (by the course of the stream) up the Ontonagon River. They began work in what are called the "*ancient diggings*." This "digging" was simply an *open trench*, some ten to twelve feet wide, running on the course of a mineral vein that had been excavated by the "ancients" in the "country rock" to uncover the vein. I do not now recollect the length of that particular trench. The country is full of them.

I give you what Mr. William Hickok, one of the owners and originators of the Minnesota mine—which mine, by-the-way, has produced several million dollars' worth of copper—and who now resides at Tarrytown in this State, says of their work and what they found. In reply to a note I addressed him respecting it on the 25th ultimo, he writes: "The mass of copper discovered by Mr. Knapp in the Minnesota mine in 1848, of which you inquire, was found in the vein, resting upon skids about twenty-five feet from the surface. It weighed 12,480 pounds. All the rock had been cleaned from its surface, giving it the appearance of being as pure as *refined copper*. There were found in the excavation a large number of 'stone hammers,' weighing from one to forty pounds each, and encircled by a 'groove' cut undoubtedly for the purpose of receiving a hickory 'withe,' to be used as a handle. There were also several copper implements, such as chisels, etc., found, that showed, from the manner they had been used—the battered heads of the chisels, for instance—that the '*art*' of hardening and welding that metal (an art now lost) was known by those who had made them. There was at that time growing in that excavation (which was filled with alluvial soil) over the vein and the mass of copper a hemlock-tree, of about three hundred and seventy-five years' growth, judging from the number of its concentric rings. We must, I think, go back to the 'stone age' to find the workers of these copper-mines. The discovery of the mass of copper in the vein of the Minnesota mine entirely free from rock, ready to be moved, unlocks the mystery of those 'floating masses'—that seen by General Cass was one of them—found in various places on the surface, showing that they had all been mined and taken from the veins, and had been abandoned while being transported to the lake, for some cause to us unknown."

It occurs to me that, if the foregoing is added to Professor Winchell's very valuable paper, the account of those remarkable min-

eral deposits will be somewhat more complete. Yours very truly,

C. A. Trowbridge.

New York, *September* 6, 1881.

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### NUMBER-FORMS AND COLORS.

*Messrs. Editors.*

In "The Visions of Sane Persons," in the "Monthly" for August, the author, Francis Galton, speaks of a certain proportion of people (five per cent.) to whom the thought of a series of consecutive numbers invariably brings the vision of them arranged in a perfectly defined and constant position.

From my earliest recollection, numbers have always appeared to me arranged in a straight line of regularly increasing height, extending from north to south: 1 is flat on the ground; 2 close to it, but a little higher and a little farther to the south, and so on. The row of figures extends upward at an angle of about forty degrees. I said that 1 was flat on the ground. I do not mean the literal ground, for the whole vision appears surrounded by and outlined against that brownish-red light which falls through our closed lids upon our eyes, when we shut them in the full glare of sunlight. I meant that 1 is at the feet of the imaginary person who, wishing to read these numbers, stands with his back to the north, looking southward and upward at this regularly ascending row.

Not only do they have position; they also have color—that is, nearly all of them. The conception of color or non-color is associated with them all: 1 is transparent, like glass or water; 2 has a reddish tinge; 3 is a bluish-green (I have in mature years seen the exact shade that my childish imagination invested this number with—in shallow bays, and waters of the tropical Pacific); 4 is also red, but a different shade from 2—more of a crimson; 5 is a very pretty, delicate gray, always spotless—a Quaker woman's dress reminds me of 5; 6 is a deeper shade of 3, a deeper blue-green; 7 I always disliked. It is a yellowish brown, the hue of withered fields and bare earth in winter, when there is no snow on the ground; 8 is black; 9 is a decided green, a darker shade of 3 and 6. Whether this is because it combines them I can not say; 10 is colorless, being composed of two numerals that are colorless, though, as previously indicated, the conception of non-color is associated with it.

The 'teens likewise have colors, but not individual ones. The numeral in the units' column gives color to the whole, though it is somewhat diluted by the colorless quality of the 1 by which it stands. It is as if an equal quantity of clear water had been poured into a colored liquid. In the numbers above twenty, sometimes one numeral, sometimes another, gives color to the number, but this is done in an arbitrary manner, and I can perceive no rule. These higher numbers, too, are somewhat confused, not so clear as those of lower denomination. The only ones that are distinct are 22, 33, 44, 55, etc. I will add, in conclusion, that there is connected with them no conception beyond form, position, and color.

Will some chemist, or some one well read in history, please explain the allusions and references in this passage from Victor Hugo's "Les Misérables"? It will be found in Chapter CCXLIX, of Lascelles Wraxall's translation: "It was from the drain of Münster that John of Leyden produced his false moon; and it was from the cesspool-well of Kekhscheb that his Oriental Menæchmus, Mokannah, the veiled prophet of Khorassan, brought his false sun."

Louise Coffin Jones.

Oskaloosa, Iowa, *August* 5, 1881.

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## EDITOR'S TABLE.

### *BALANCE AND COMPENSATION OF INORGANIC FORCES.*

It was some forty years ago that the organic chemists, represented by such masters as Dumas and Liebig, worked out the beautiful idea of the balance of organic nature. They showed that the vegetable and animal kingdoms carry on antagonist processes—each for ever undoing the work of the other. The atmosphere is the arena of this subtile conflict, being poisoned by the animal world and purified by the vegetable world; while these opposing processes so effectually counteract each other, that the air is automatically maintained in a condition fitted for the preservation of the living races.

A corresponding balance of forces is displayed on a grand and still more striking scale in the inorganic world, by which the varied configuration of the earth's surface and the continued habitability of the globe are maintained.

In his new and very interesting book on "Volcanoes," Professor J. W. Judd, of London, has taken up this subject, and his chapter on "The Part played by Volcanoes in the Economy of Nature" impresses us like a powerful sermon on the old problem of good and evil—and that has also something *new* in it. Professor Judd does not dwell upon the moral aspect of the subject, but we can not better introduce his view to our readers than by a reference to its ethical implications.

Nothing, of course, can have less claim upon the attention of men whose intelligence, however considerable of its sort, has never been directed to the understanding of nature, than what goes on in the interior of the earth. That, says a representative of this class, belongs to scientific speculation, and is no concern of his. He knows, indeed, of earthquakes and volcanoes as deadly agencies by which great numbers of lives are often ruthlessly destroyed; and he regards them as conspicuous examples of diabolism in nature; and when he hears it said that "volcanoes are the safety-valves of the globe," he is very glad to know that they have some possible use, however remote.

Now, ethics—the science of right and wrong, of good and bad—is certainly not an exact science; and yet it has a quantitative basis. In the constitution of this world, good and evil are inextricably mixed up, and the problem of their proportions is therefore fundamental in ethical inquiries. There is always more or less of each, and there are degrees of both. We are familiar with the terms small and great in their applications to evil and good, and we labor to diminish the former and increase the latter. It is natural that the estimates of the relative amounts of good and evil should vary, especially as so much depends upon the subjective condition of the estimator. The pessimist admits that there may be hours and perhaps places in which good prevails; but he maintains that, on the whole, evil so greatly predominates that life is not worth living. The optimist holds on the contrary that, while evil may be supreme at times, good is ascendant in the large view. The question between them, therefore, is mainly one of relative quantities.

If, now, it can be shown that in any given case good prevails over evil, say in the ratio of one hundred thousand to one, it is obvious that the pessimist will not have much margin left upon which to make a stand; and, if it can be further proved that this ratio holds on a stupendous scale, and, moreover, that it includes just those malign manifestations of Nature that are most cited as evidence of her vicious spirit, the pessimist will be left in a still worse predicament. This position may be familiarly illustrated. A certain considerable amount of life is violently destroyed each year by lightnings, storms, and floods; yet these effects are only the calamitous incidents of a great system of circulation of water and air over our globe by which all life is maintained. That system of movements gives good and evil, but, compared with their beneficence, the disastrous results they produce are absolutely insignificant. If we say that the good prevails over the evil at the rate of a million to one, the estimate is still very far within the limits of truth.

Professor Judd has shown that the same principle holds in regard to volcanoes and earthquakes. We know that by these agencies dwellings, villages, and even entire cities are reduced to heaps of ruins, often with the direct destruction of multitudes of people, and furthermore that famines, pestilences, and social disorganizations frequently follow. But these catastrophes, terrible as they may be, are the results of a system of overwhelming beneficence. The subterranean energies, of which earthquakes and volcanoes are the striking manifestations, are necessary to

the continued existence of our earth as a place fitted for the habitation of living beings, and they must be credited with the total amount of benefit implied by the existence and preservation of the life of the globe in all its forms and gradations. We quote enough of the argument of Professor Judd, in his elaborate chapter upon this subject, to substantiate the view here taken:

We have had frequent occasion in the preceding pages to refer to the work—slow but sure, silent but effective—wrought by the action of the denuding forces ever operating upon the surface of our globe. The waters condensing from the atmosphere and falling upon the land in the form of rain, snow, or hail, are charged with small quantities of dissolved gases, and these waters, penetrating among the rock-masses of which the earth's crust is composed, give rise to various chemical actions of which we have already noticed such remarkable illustrations in studying the ancient volcanic products of our globe. By this action the hardest and most solid rock-masses are reduced to a state of complete disintegration, certain of their ingredients undergoing decomposition, and the cementing materials which hold their particles together being removed in a state of solution. In the higher regions of the atmosphere this work of rock-disintegration proceeds with the greatest rapidity; for there the chemical action is reënforced by the powerful mechanical action of freezing water. On high mountain-peaks the work of breaking up rock-masses goes on at the most rapid rate, and every craggy pinnacle is swathed by the heaps of fragments which have fallen from it. The Alpine traveler justly dreads the continual fusillade of falling rock-fragments which is kept up by the ever-active power of the frost in these higher regions of the atmosphere; and fears lest the vibrations of his footsteps should loosen, from their position of precarious rest, the rapidly accumulating piles of detritus. No mountain-peak attains to any very great elevation above the earth's surface, for the higher we rise in the atmosphere the greater is the range of temperature and the more destructive are the effects of the atmospheric water. The moon, which is a much smaller planet than our earth, has mountains of far greater elevation; but the moon possesses neither an atmosphere nor moisture on its surface, to produce those leveling effects which we see everywhere going on around us upon the earth.

The disintegrated materials, produced by chemical and mechanical actions of the atmospheric waters upon rock-masses, are by floods, rivers, and glaciers, gradually transported from higher to lower levels; and sooner or later every fragment, when it has once been separated from a mountain-top, must reach the ocean, where these materials are accumulated and arranged to form new rocks.

Over every part of the earth's surface these three grand operations of the disintegration of old rock-masses, the transport of the materials so produced to lower levels, and the accumulation of these materials to form new rocks, are continually going on. It is by the varied action of these denuding agents upon rocks of unequal hardness, occupying different positions in relation to one another, that all the external features of hills, and plains, and mountains owe their origin.

It is a fact, which is capable of mathematical demonstration, that by the action of these denuding forces the surface of all the lands of the globe is being gradually but surely lowered; and this takes place at such a rate that in a few millions of years the whole of the existing continents must be washed away and their materials distributed over the beds of the oceans.

It is evident that there exists some agency by which this leveling action of the denuding forces of the globe is compensated; and a little consideration will show that such compensating agency is found in the subterranean forces ever at work within the earth's crust. The effects of these subterranean forces which most powerfully arrest our attention are volcanic outbursts and earthquake-shocks, but a careful study of the subject proves that these are by no means the most important of the results of the action of such forces. Exact observation has proved that almost every part of the earth's surface is either rising or falling, and the striking and destructive phenomena of volcanoes and earthquakes probably bear only the same relation to those grand and useful actions of the subterranean forces which floods do to the system of circulating waters and hurricanes to the system of moving air-currents. . . .

We establish the fact of the movement of portions of the earth's crust by noticing the changing positions of parts of the earth's surface in relation to the constant level of the ocean. When this is done we find abundant proof that, while some parts of the earth's crust are rising, others are as undoubtedly undergoing depression.

We shall be able to form some idea of the vastness of the effects produced by the sub-

terranean forces, by a very simple consideration. It is certain that during the enormous periods of time of which the records have been discovered by the geologist, there have always been continents and oceans upon the earth's surface, just as at present, and it is almost equally certain that the proportions of the earth's surface occupied by land and water respectively have not varied very widely from those which now prevail. But, at the same time, it is an equally well-established fact that the denuding forces ever at work upon the earth's surface would have been competent to the removal of existing continents many times over, in the vast periods covered by geological records. Hence we are driven to conclude that the subterranean movements have in past times entirely compensated for the waste produced by the denuding forces ever at work upon our globe. But this is not all. The subterranean forces not only produce upheaval; in a great many cases the evidences of subsidence are as clear and conclusive as are those of upheaval in others. Hence we are driven to conclude that the forces producing upheaval of portions of the earth's crust are sufficient, not only to balance those producing subsidence, but also to compensate for the destructive action of denuding agents upon the land-masses of the globe.

It is only by a careful and attentive study and calculation of the effects produced by the denuding agents at work all around us, aided by an examination of the enormous thicknesses of strata formed by the action of such causes during past geological times, that we are able to form any idea of the reality and vastness of the agents of change which are ever operating to modify the earth's external features. When we have clearly realized the grand effects produced on the surface of the globe by these external forces, through the action of its investing atmosphere and circulating waters, then, and only then, shall we be in a position to estimate the far greater effects resulting from the internal forces, of which the most striking, but not the most important, results are seen in the production of volcanic eruptions and earthquake-shocks.

Another series of facts which serves to convince the geologist of the reality and potency of the forces ever at work within the earth's crust, and the way in which these have operated during past geological periods, is found in the disturbed condition of many of the stratified rock-masses of which it is composed. Such stratified rock-masses, it is clear, must have been originally deposited in a position of approximate horizontality; but they are now often found in inclined and even vertical positions; they are seen to be bent, crumpled, puckered, and folded in the most remarkable manner, and have not unfrequently been broken across by dislocations — "faults" — which have sometimes displaced masses, originally in contact, to the extent of thousands of feet. The slate-rocks of the globe, moreover, bear witness to the fact that strata have been subjected to the action of lateral compression of enormous violence and vast duration; while in the metamorphic rocks we see the effects of still more extreme mechanical strains, which have been in part transformed into chemical action. No one who has not studied the crushed, crumpled, fractured, and altered condition of many of the sedimentary rocks of the globe, can form the faintest idea of the enormous effects of the internal forces which have been in operation within the earth's crust during earlier geological periods. And it is only by such studies as these that we at last learn to regard the earthquake and volcanic phenomena of our globe, not as the grandest and most important effects of these forces, but as their secondary and accidental accompaniments.

**Professor Judd here passes to a very lucid presentation of the later views of geologists in regard to the mode of origin and development of mountains. This is an important part of his discussion, but we have no room for it here. He concludes:**

From what has been said, it will be seen that mountain-chains may be regarded as cicatrized wounds in the earth's solid crust. A line of weakness first betrays itself at a certain part of the earth's surface by fissures, from which volcanic outbursts take place; and thus the position of the future mountain-chain is determined. Next, subsidence during many millions of years permits of the accumulation of the raw materials out of which the mountain-range is to be formed; subsequent earth-movements cause these raw materials to be elaborated into the hardest and most crystalline rock-masses, and place them in elevated and favorable positions; and lastly, denudation sculptures from these hardened rock-masses all the varied mountain forms. Thus the work of mountain-making is not, as was formerly supposed by geologists, the result of a simple upheaving force, but is the outcome of a long and complicated series of operations.

The careful study of other mountain-chains, especially those of the American Con-

tinent, has shown that the series of actions which we have described as occurring in the Alps took place in the same order in the formation of all mountain-masses. It is doubtful whether the line of weakness is always betrayed in the first instance by the formation along its course of volcanic fissures. But in all cases we have evidence of the production of a geosynclinal, which is afterward, by lateral pressure, converted into a geanticlinal, and from this the mountain-chains have been carved by denudation. Professor Dana has shown that the geosynclinal of the Appalachian chain was made up of sediments attaining a thickness of forty thousand feet, or eight miles; while Mr. Clarence King has shown that a part of the geosynclinal of the Rocky Mountains was built up of no less than sixty thousand feet, or twelve miles of strata.

It has thus been established that a very remarkable relation exists between the forces by which continental masses of land are raised and depressed and mountain-ranges have been developed along lines of weakness separating such moving continental masses and those more sudden and striking manifestations of energy which give rise to volcanic phenomena. It is in this relation between the widespread subterranean energies and the local development of the same forces at volcanic vents that we must in all probability seek for the explanation of those interesting peculiarities of the distribution of volcanoes upon the face of the globe which we have described in a former chapter. The parallelism of volcanic bands to great mountain-chains is thus easily accounted for; and in the same way we may probably explain the position of most volcanoes with regard to coast-lines. . . .

Terrible and striking, then, as are the phenomena connected with volcanic action, such sudden and violent manifestations of the subterranean energy must not be regarded as the only, or indeed the chief, effects which they produce. The internal forces continually at work within the earth's crust perform a series of most important functions in connection with the economy of the globe, and, were the action of these forces to die out, our planet would soon cease to be fit for the habitation of living beings. . . .

It is by no means a difficult task to calculate the approximate rate at which the various continents and islands are being leveled down, and such calculations prove that in a very few millions of years the existing forces operating upon the earth's surface would reduce the whole of the land-masses to the level of the ocean. . . .

But, by the admirable balancing of the external and internal forces on our own globe, the conditions necessary to animal and vegetable existence are almost constantly maintained, and those interruptions of such conditions, produced by hurricanes and floods, by volcanic outbursts and earthquakes, may safely be regarded as the insignificant accidents of what is, on the whole, a very perfectly working piece of machinery.

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## LITERARY NOTICES.

THE ANCIENT BRONZE IMPLEMENTS, WEAPONS, AND ORNAMENTS OF GREAT BRITAIN AND IRELAND. By JOHN EVANS, D. C. L., LL. D., F. R. S., F. S. A., F. G. S., President of the Numismatical Society, etc. New York: D. Appleton & Co. 1881. Pp. 509. Price, $5.

A FEW years ago there appeared a portly volume, profusely illustrated, and entitled "The Ancient Stone Implements and Ornaments of Great Britain." It was a monument of careful observation and painstaking labor in a new field, with not many enthusiastic explorers, and was at once accepted as a trustworthy and authoritative work upon the subject, which, although chiefly confined to Great Britain, was an important contribution to the general science of archæology. Mr. John Evans, the author of that work, has continued to devote himself to the field of archaic research, and now publishes a corresponding volume on "The Ancient Bronze Implements, Weapons, and Ornaments of Great Britain and Ireland."

We have here a history more ancient than written history, and which reveals the social state, the conditions of culture and development of prehistoric man. These are determined by the evidences of what he did, the relics that remained and have been found, of what he invented and constructed to meet his wants. His first tools and weapons were of stone, and the period when he employed them is the earliest of which we have any trace, and is called the "Stone Age." But there was an education in these rude constructions which led to progress, so that this most ancient period has been divided into two stages, the Palæolithic or the very earliest, and the Neolithic or later stone age, which exhibits a marked advancement in the art of producing stone implements.

The next step of prehistoric progress consisted in entering upon the use of metal instead of stone for the construction of weapons and implements of industry. It is probable that gold, which commonly occurs native and brilliant, was the first metal that attracted the attention of mankind; and it is likely that the next metal discovered was copper, which also occurs native, and has many points of resemblance to gold. It was found in sufficient abundance to be available for working, and was probably the material out of which the first metallic utensils were manufactured. The State of Wisconsin alone has furnished upward of one hundred axes, spear-heads, and knives formed of copper. On the shores of Lake Superior native copper occurs in great abundance, and no doubt attracted the attention of the early occupants of the country. Dr. Evans remarks that, "accustomed to the use of stone, they would at first regard the metal as a stone of peculiarly heavy nature, and on attempting to chip it or work it into shape would at once discover that it yielded to a blow instead of breaking, and that in fact it was a malleable stone." The great majority of these copper instruments hitherto found, if not all, have been hammered and not cast, so that the working of metal into shape by melting it was probably a later acquisition. There is reason to believe that there was what may be called a "Copper Age," in parts of North America, but in Europe the traces of it are feeble, if not totally wanting.

Bronze is formed by the admixture or alloy of tin with copper in the molten state, and the effect of this mixture results in hardening the product, so that the resulting bronze becomes much more useful for many mechanical purposes than copper. There is overwhelming evidence that bronze greatly predominated for these purposes before iron was employed; the passage to iron and steel constituting a further step of advancement, and leading to a subsequent "Iron Age." Bronze abounded in ancient Egypt, while iron was but little used, and there are only thirteen references to iron in the Pentateuch, while bronze is mentioned forty-four times.

Dr. Evans's volume contains 540 illustrations of hatchets, chisels, gouges, hammers, sickles, knives, razors, daggers, halberds, maces, swords, scabbards, spear-heads, shields, trumpets, bells, pins, bracelets, rings, clasps, buttons, buckles, and vessels of all kinds, that are formed of bronze, and that have been collected and classified with the view of throwing light upon the history of the "Bronze Period." And in regard to their scientific significance the author remarks: "It may by some be thought that a vast amount of useless trouble has been bestowed in figuring and describing so many varieties of what were, after all, in most cases, the ordinary tools of the artificer, or the common arms of the warrior or huntsman, which differed from each other only in apparently unimportant particulars. But as in biological studies minute anatomy often affords the most trustworthy evidence as to the descent of any given organism from some earlier form of life, so these minor details in the form and character of ordinary implements, which to the cursory observer appear devoid of meaning, may, to a skillful archæologist, afford valuable clews by which the march of the bronze civilization over Europe can be traced to its original starting-place. I am far from saying that this has as yet been satisfactorily accomplished, and to my mind it will only be by accumulating a far larger mass of facts than we at present possess that comparative archæology will be able to triumph over the difficulties with which its path is still beset."

THE JOURNAL OF PHYSIOLOGY. Edited by Gamgee, Rutherfurd, Burdon-Sanderson, Bowditch, Martin, Wood, and Michael Foster.

WE have received numbers I and II of Volume III of this important periodical, together with the supplement of Volume III, and we again call attention to it as having high claims upon the medical profession and all interested in the progress of physiological science. It is conducted by the very ablest men in England and this country, and, by their labors and the contributions of other investigators, it thoroughly represents the advance of research in this fruitful field of inquiry. The papers in number I, "On the Antagonism of Poisons," "The Influence of Quinine upon the Reflex Excitability of the Spinal Cord," "The Rate of Propagation of the Arterial Pulse-Wave,"

"The Tonicity of the Heart and Blood-Vessels"; and the articles in number II, "On the Proteid Substances contained in the Seeds of Plants," "The Influence of Season and of Temperature on the Action and the Antagonisms of Drugs," and "The Elastic Properties of the Arterial Wall," are especially noteworthy, and their conclusions of much scientific interest. The supplement gives an extensive list of titles of books and papers upon physiological questions, in all the modern languages, that have appeared in 1880. Six numbers form a volume of about 500 pages, the American subscription of which is $5, and may be remitted to Mr. W. T. Sedgwick, Johns Hopkins University, Baltimore, Maryland. The American edition of the Journal now appears under the auspices of that institution.

INTERNATIONAL SCIENTIFIC SERIES.—NO. XXXV.

VOLCANOES: WHAT THEY ARE AND WHAT THEY TEACH. By JOHN W. JUDD, F. R. S., Professor of Geology in the Royal School of Mines. With 96 Illustrations. New York: D. Appleton & Co. Pp. 381. Price, $1.75.

IN no field has modern research been more fruitful than in that of which Professor Judd gives a popular account in the present volume. The great lines of dynamical, geological, and meteorological inquiry converge upon the grand problem of the interior constitution of the earth, and the vast influence of subterranean agencies. The subject was first comprehensively dealt with in the light of modern scientific views by the late Mr. Poulett Scrope, who published two systematic treatises upon different divisions of it in the years 1825 and 1827. Professor Judd was a student and disciple of this master, who, before he died, committed to him the task of preparing a popular exposition of the present condition of our knowledge on volcanoes. Since the time of Scrope's publication many important additions have been made to the subject, and these the author has faithfully incorporated in the book now issued. The plan and spirit of the work are thus indicated in his preface:

"In order to keep the work within the prescribed limits, and to avoid unnecessary repetitions, I have confined myself to the examination of such selected examples of volcanoes as could be shown to be really typical of all the various classes which exist upon the globe; and I have endeavored from the study of these to deduce those general laws which appear to govern volcanic action. But it has, at the same time, been my aim to approach the question from a somewhat new standpoint, and to give an account of those investigations which have in recent times thrown so much fresh light upon the whole problem. In this way I have been led to dwell at some length upon subjects which might not at first sight appear to be germane to the question under discussion—such as the characters of lavas revealed to us by microscopic examination; the nature and movements of the liquids inclosed in the crystals of igneous rocks; the relations of minerals occurring in some volcanic products to those found in meteorites; the nature and origin of the remarkable iron-masses found at Ovifak in Greenland; and the indications which have been discovered of analogies between the composition and dynamics of our earth and those of other members of the family of worlds to which it belongs. While not evading the discussion of theoretical questions, I have endeavored to keep such discussions in strict subordination to that presentation of the results attained by observation and experiment, which constitutes the principal object of the work."

We are not acquainted with any other work of Professor Judd, but he is an experienced and very agreeable writer, and is evidently a master of the art of statement. His book is very far from being a mere dry description of volcanoes and their eruptions; it is rather a presentation of the terrestrial facts and laws with which volcanic phenomena are associated. We give an extract in our editorial pages which well represents the quality of the book. The illustrations are numerous, well chosen, and especially fine in execution; and the volume is among the best of the series to which it belongs.

THE BIBLE AND SCIENCE. By T. LAUDER BRUNTON, M. D., D. S. C., F. R. S. With Illustrations. Macmillan & Co. 1881. Pp. 415. Price, $2.50.

THIS book is an example on a small scale of the common remark that "history

repeats itself." It belongs to the literature of reconciliation of religion and science, and does over again what had been so often done before that its repetition should be superfluous—that is, if people were not so stupid.

When the laws of planetary motion were discovered, devout Bible-believers took the alarm and denounced the doctrine as destructive of religion. A war arose between the new science and the old Church, which was at length composed by a reinterpretation of Scripture passages, and everybody has become reconciled except Brother Jaspar.

But no sooner was the Bible brought into harmony with astronomy, than the same difficulty broke out in another place. Geologists found that the earth and the life upon it are a good deal older than have been supposed; but this was vehemently declared to be in conflict with the text of the old Hebrew oracles. The geologists were charged with being subverters of religion, and there was a long battle about it. But a way was discovered to reconcile Genesis with the new views of the earth's history, and the alarmed believers found not only that they had been a good deal more scared than hurt, but, greatly to their gratification, that Moses was the true founder of geological science.

One would think that by this time something might have been learned, and very much indeed has been learned, but there are multitudes of religious people who are still exactly where stood the religious people of three centuries ago. Another religious panic is upon us, from the same old cause. Science has proclaimed evolution as an established law of nature, and the believers in the killing letter of Scripture see another crusade of infidelity which, cloaking itself with the name of science, aims at the subversion of Christianity. Dr. Brunton's work grows out of this crisis, and is devoted to the old task of reconciliation.

There are many nominally religious people upon whom this sort of labor is quite thrown away. There must be some sincere solicitude for truth before there can be much concern about its agreements. It is not to be expected that those who are religious in obedience to the requirements of Mrs. Grundy will greatly trouble themselves about the conflicts of their faith. Then there are others, not wanting perhaps in sincerity, to whom religion is a mere safeguard against future life-dangers, and these, of course, will care little about the relations of their religion to knowledge. They have nothing to reconcile, nothing to be explained away. They have merely a system of supernaturalism to be professed, with divers accompaniments, as a means of escaping from everlasting perdition. But there are still many conscientious people who, having arrived at no general principles to govern the case, are perplexed at the disagreements between the accepted tenets of religious belief and the progressive doctrines of science. Dr. Brunton's book is written for this order of minds, and with reference to the new issues between the Bible and science which have arisen in our own age. But it is best to let the author speak for himself in regard to his purpose. He says: "Many people consider the doctrine of evolution, or, as it is not unfrequently termed, Darwinism, as necessarily atheistic, and regard it with horror mingled with fear. They look upon it with horror, because they think that its spread will be injurious to religion and morality; and they fear it, because they see that every year its adoption is becoming more general, and that, notwithstanding their dislike to it, they are unable to stop its progress. In addition to this, some have a lurking dread that the doctrine may be true, and that they may by-and-by be forced, in spite of themselves, to acknowledge its truth, and to give up the cherished religious beliefs which have been their joy and strength. Feelings of this sort induce some people to remain willfully ignorant both of what the doctrine of evolution really is, and the arguments that may be adduced in support of it, while others refuse to see the force of the arguments; and others, again, are rendered most unhappy by their inability to deny their truth. The objects of the present work are to give a brief and popular sketch of the data on which the doctrine is founded, and to show that instead of being atheistic it is the very reverse, and is no more opposed to the Biblical account of the creation than those geological doctrines regarding the structure and formation of the earth's crust which were once regarded as

heretical and dangerous, but are now to be found in every class-book and are taught in every school."

Dr. Brunton's volume is not at all of the controversial form, and is quiet in tone and most conciliatory in spirit. It is besides a very instructive book, his plan being not so much to argue his questions in a formal way as to give the information and illustrate the facts that will enable the reader to draw his own conclusions.

The method of the book is somewhat novel. It is divided into two parts, which are so separate and so different that the reader is left long in doubt as to their connection or what they have to do with each other. The three introductory chapters are devoted to an account of Bible lands, or the countries of Egypt and Palestine, and the Exodus of the Hebrews. This part of the work is of extreme interest, because of the freshness of its restatement of old facts in the light thrown upon them by later knowledge. The countries of Egypt and Palestine are regarded as typical specimens of regions where the climatic conditions were entirely different, so that abundance prevailed in one while famine desolated the other, and drove a starving people to one of those wholesale migrations which have played so important a part in the world's history. Ancient Egyptian life has been dwelt upon to fix attention upon an old civilization as a landmark of the world's progress, so that the long centuries which have since intervened might introduce to the conception of geological time. The influence of circumstances upon character and the law of the hereditary transmission of qualities are variously exemplified by the Israelitish race.

Fifty pages of the work are consumed in this preliminary discussion, and then the next 286 pages are devoted to such a general survey of the vegetable and animal kingdoms, in the present structures and affinities of living species and in the relations of the earth's historic life displayed by fossils, as brings out in an impressive manner the truth of the doctrine of evolution. This portion of the work is highly instructive, from the richness of its facts and the copiousness of the pictorial illustrations which help their interpretation. But it is mainly valuable, of course, as showing the extent, the variety, and the harmony of the proofs that can be given of the law of development. This law being established, the author proceeds in Lecture XVI to consider "The Mosaic Record and Evolution." There is here no straining after effect, but it is shown how the honest believer in the Scriptures need have no real difficulty in interpreting the Biblical text in harmony with evolutional truth. A rigorous literalism can, of course, make a stand here, as it did in the times of the astronomical and geological controversy; but there is a good deal less difficulty with the reconciliation now than there was in the preceding cases. The closing lecture is devoted to individual development, and gives occasion to some practical conclusions and reflections suggested by the subject, which are full of instructive interest.

REPORT OF ANALYTICAL AND OTHER WORK DONE ON SORGHUM AND CORN-STALKS BY THE CHEMICAL DIVISION OF THE DEPARTMENT OF AGRICULTURE. By PETER COLLIER, Chemist. Washington: Government Printing-Office. 1880. Pp. 101, with Twenty-seven Plates.

THE object of the work reviewed in this report is to ascertain as many facts as possible in relation to the development and actual composition of the stalks and juices of the different varieties of sorghum and corn which can be successfully grown in the United States. The experiments were generally directed to the demonstration of the period at which the juice of each particular variety of sorghum or corn contained the most crystallizable sugar which could be profitably separated. Large sheet plates present graphically the results of 3,601 analyses of thirty-eight varieties of sorghum, eleven varieties of corn-stalks, and a few outside samples of sugar and sirup.

NASO-PHARYNGEAL CATARRH. By MARTIN F. COOMES, M. D., Professor in the Kentucky School of Medicine. Louisville, Kentucky: Bradley & Gilbert. Pp. 165. Price, $2.

THIS book, the author tells us, was prepared by request, as a practical treatise for the use of general practitioners of medicine. It treats of the anatomy of the parts

liable to catarrhal affections, the examination of the pharynx, the value and method of local and constitutional medication, and the remedies used, the effect of climate on hay-fever, and the pathology and treatment of catarrh, and acute sporadic catarrh, with descriptions of many cases.

THE HYSTERICAL ELEMENT IN ORTHOPÆDIC SURGERY. By NEWTON M. SHAFFER, M. D., Surgeon in charge of the New York Orthopædic Dispensary and Hospital, etc. New York: G. P. Putnam's Sons. Pp. 66. Price, $1.

CASES of knee-joint disease, hip-joint disease, Pott's disease, lateral curvatures, and club-foot, have come before the author in his practice, which were not real, but the result of hysterical affection, or what he calls nervous mimicry. Some of them existed in persons who had never seen a genuine case of the disease with which they presumed they were afflicted. The present volume gives the diagnosis of such cases, with accounts of the method and results of treatment.

BRIEF REVIEW OF THE MOST IMPORTANT CHANGES IN THE INDUSTRIAL APPLICATIONS OF CHEMISTRY WITHIN THE LAST FEW YEARS. By J. W. MALLET, F. R. S. Pp. 98.

THIS work hardly needs any other notice than the transcription of its title, which fully defines its purpose and scope. It is full of instructive facts, valuable for practical application in nearly every department of the arts. The improved chemical processes and applications which it describes in classified detail, when brought together and considered in the aggregate, are significant of the great and wonderful advance that has been made in all that contributes to the economy and comfort of life.

EDUCATIONAL JOURNALISM. An Address before the New York State Teachers' Association, at its Thirty-sixth Annual Meeting, Saratoga Springs, August 7, 1881. By C. W. BARDEEN. Syracuse, New York: C. W. Bardeen. Pp. 30.

THIS address gives the history of the older and of some of the most famous educational journals of the country, with remarks on the value of publications of that class.

A FATAL FORM OF SEPTICÆMIA IN THE RABBIT PRODUCED BY THE SUBCUTANEOUS INJECTION OF HUMAN SALIVA. An Experimental Research. By GEORGE M. STERNBERG, Surgeon United States Army. Baltimore: John Murphy & Co. 1881. Pp. 22.

IN this interesting research the author discovered that the injection of his saliva into the subcutaneous connective tissue of a rabbit infallibly produced the death of the animal, usually within forty-eight hours. Experiments with the saliva of other persons resulted variously; some salivas appearing to be more virulent than others. These facts afford an interesting commentary on the discovery announced by Pasteur of a "new disease" produced by the injection of the saliva of infants which have died from hydrophobia. The experiments are described in detail, and photographs of the septic organisms developed after the injections are also given.

WHAT SHALL WE DO WITH THE INEBRIATE? By T. D. CROTHERS, M. D. Pp. 24.

THE author of this pamphlet, who is superintendent of a home for the treatment of inebriates and opium cases at Hartford, Connecticut, and who may therefore be supposed to know something of the subject about which he writes, controverts the theory that drunkenness is a vice to be counteracted by moral and penal influences only. He regards it as a disease requiring peculiar treatment, and divides inebriates into three classes, to whose condition the method of treatment requires to be specially adapted. Thus managed, he believes inebriety to be as curable as other forms of disease.

FIFTH ANNUAL REPORT OF THE STATE BOARD OF HEALTH OF WISCONSIN. 1880. Madison, Wisconsin: David Atwood, State Printer. Pp. 156.

BESIDES the accounts of the operations of the Board and the condition of health of the State, this report contains a number of special papers prepared for the information of the people, on such subjects as "General Hygienic Knowledge a Necessity for the People," "Recreation as a Sanitary Agent," "School Hygiene," "The Management of Contagious Diseases in the City of Milwaukee," "Diseased Meat and its Relations to Health," and "Kerosene."

SYNOPSIS OF THE FRESH-WATER RHIZOPODS. A Condensed Account of the Genera and Species, founded upon Professor Joseph Leidy's "Fresh-Water Rhizopods of North America." Compiled by ROMYN HITCHCOCK, F. R. M. S. New York: Romyn Hitchcock, 51 and 53 Maiden Lane. Pp. 56.

RHIZOPODS form a division of the *Protozoa*, and consist, essentially, of a soft mass of clear or granular protoplasm, usually colorless, with one or more nuclei and contractile vesicles. They are mostly microscopic, are quite common, and may be found in the settlings of still water, in the slime of submerged rocks, stems, and leaves, and in similar situations. The author hopes, by means of this work, which is devoted to the description of genera and species, to facilitate the study of these interesting organisms.

THE MINERAL RESOURCES OF THE HOCKING VALLEY; BEING AN ACCOUNT OF ITS COALS, IRON-ORES, BLAST-FURNACES, AND RAILROADS. By T. STERRY HUNT, LL. D. With a Map. Boston: S. E. Cassino. Pp. 152.

THE Hocking Valley coal-field of Ohio occupies an area of about two hundred and fifty square miles, in the region drained by the Hocking River, and is characterized by the exceptional thickness and value of its coal-beds. It contains, also, extensive beds of good iron-ores and quarries of limestone, and thus combines rare advantages to encourage the establishment of iron-works. It is well supplied with railroads connecting it with important commercial centers which can be supplied with coal more conveniently from it than from any more distant source. All of these points are set forth clearly and in detail in the present report.

BUTTERFLIES: THEIR STRUCTURE, CHANGES, AND LIFE-HISTORIES, with Special Reference to American Forms. Being an Application of the "Doctrine of Descent" to the Study of Butterflies, with an Appendix of Practical Instructions. By SAMUEL H. SCUDDER. New York: Henry Holt & Co. Pp. 322. Price, $3.

A BOOK intended to awaken interest in the study of butterflies, and to assist in intelligent observation. It begins with the life-history of the insect, from the egg through the stages of the caterpillar, the chrysalis, and the perfect insect; describes its internal organs, with careful illustrations of its anatomy, its habits in all its stages, its seasonal changes and histories, and its coloring, "with further histories," and discusses the diversity of the sexes in coloring and structure, the origin and development of ornamentation, the ancestry and classification and geographical distribution of butterflies, and suggests a theory of the way in which New England was colonized with the insects. In the appendix are given instructions for collecting, rearing, preserving, and studying butterflies, the bibliography of the subject, and a systematic list of butterflies mentioned in the text. The whole is fully illustrated, generally from American specimens.

PRIMITIVE INDUSTRY; OR, ILLUSTRATIONS OF THE HAND-WORK, IN STONE, BONE, AND CLAY, OF THE NATIVE RACES OF THE NORTHERN ATLANTIC SEABOARD OF AMERICA. By CHARLES C. ABBOTT, M. D. Salem, Massachusetts: George A. Bates. 1881. Illustrated. Pp. 560. Price, $3.

THE title of this book describes in the fullest manner its contents. Dr. Abbott has wisely chosen to limit his work to that portion of the continent in which he has collected and studied, and to which he has added so many valuable contributions. In the preface he expresses the hope that the book will "induce others to explore such localities as they have opportunity of doing, and to preserve such traces of early man as they may find *by placing them in public museums*." Dr. Abbott has strictly adhered to this advice. He has no private collection. The immense mass of material he has gathered in his State now enriches the museums of Cambridge and Salem, where at all times it is open to inspection. In the light of the author's exhaustive study of the Trenton gravels, and the various beds superimposed upon them, we think he is justified in taking exception to the views expressed by Professor Whitney that "it is evident that there has been no unfolding of the intellectual faculties of the human race on this continent which can be parallelized with that which has taken place in Central Europe. We can recognize no palæolithic, neolithic, bronze, or iron ages." Dr. Abbott shows conclusively that the evidences of a

true palæolithic and neolithic age are as marked in that section of the country he has examined as can be found in the valley of any European river.

The chapter on "Palæolithic Implements," and the contributions of Professor H. C. Lewis on "The Antiquity and Origin of the Trenton Gravels," with which the volume closes, will be of great value to those interested in this question.

It is impossible to do justice to this work in the limited space of a book notice. It is sufficient to say that the work as a contribution to the archæology of Eastern North America is by far the most important of any that has appeared in this country. The student will be greatly aided by the careful way in which the various implements are classified and named.

How Persons afflicted with Bright's Disease ought to live. By Joseph F. Edwards, M. D. Philadelphia: Presley Blakiston. Pp. 87. Price, 75 cents.

The author believes that, in many instances, persons afflicted with Bright's disease may, by proper management, enjoy comfort and comparative good health for many years, and even outlive thousands around them who are in vigorous health. The object of his treatise is to define the conditions of the proper life with which this may be accomplished. These conditions are summed up in the avoidance of whatever will irritate the kidneys and attention to keeping up the general health. The skin should be kept in good condition by regular bathing, a proper degree but no excess of exercise should be practiced, the food should be suitable and abundant, the clothing always comfortable; alcohol and tobacco and other stimulants should be avoided.

The Figure of the Earth. An Introduction to Geodesy. By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. New York: John Wiley & Sons. Pp. 88. Price, $1.50.

This work embraces the substance of "familiar talks" on the size and figure of the earth which were delivered, in 1879, to the students of civil engineering in Lehigh University. They were afterward published, with considerable extensions and improvements, and this is another revision. Its aim is to give the history of scientific investigation and opinion concerning the figure of the earth, and at the same time furnish an introduction to the science of geodesy that will possess desirable qualities for engineering students and engineers. The illustrative examples are generally from American surveys.

Rugby, Tennessee. By Thomas Hughes. London: Macmillan & Co. Pp. 168. Price, $1.

This book is put forth as the best answer which the founders of the Rugby colony can make to the questions that are asked them, chiefly in the United Kingdom, concerning their settlement. The first part answers questions respecting the class of persons for whom the place is intended. They are young men of good education and small capital. The second part consists of the letters written by Mr. Hughes last fall to the London "Spectator," reprinted without alteration. The third part, Mr. Killebrew's report, describes the natural situation and condition of the land without coloring, apparently hiding no defects. The glossary answers questions definitely and in short.

Pharmacology and Therapeutics; or, Medicine Past and Present. The Goulstonian Lectures, delivered before the Royal College of Physicians and Surgeons in 1877. By T. Lauder Brunton, M. D., F. R. S. London: Macmillan & Co. Pp. 212.

The object of these lectures was to show how the progress of therapeutics is aided by an exact knowledge of drugs obtained by experiments. The history of medicine in the past, with the course of the empiric and dogmatic systems, is reviewed, and the development described of rational and scientific methods of study, culminating in the application of the systematic investigation of the properties of drugs as illustrated especially in the case of strychnia, curare, casca, and other remedies, the adoption of which has given a new aspect to modern pharmacology and therapeutics. The *rationale* of the operation of many remedies, as brought out by the new methods of investigation, is also briefly discussed.

PUBLICATIONS RECEIVED.

Further Notes on the Pollination of Yucca and on Pronuba and Prodoxus. By C. V. Riley. Pp. 33.

Fourteenth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology. Vol. III, No. 1. Cambridge. 1881. Pp. 41.

Noxious and Beneficial Insects of the State of Illinois. Fifth Annual Report. By Cyrus Thomas, Ph. D., State Entomologist. Springfield, Illinois. 1881. Pp. 232.

Report on the Statistics of Grape-Culture and Wine-Production in the United States for 1880. By William McMurtrie, Ph. D. Washington: Government Printing-Office. 1881. Pp. 104.

The Nature of the Existence of Matter. By Edward Randall Knowles. Pascoag, R. I. 1881. Pp. 7.

The Manuscript Troano. By Professor Cyrus Thomas. Reprint from "The American Naturalist." Pp. 16.

Free Trade *vs.* Protection. By Henry J. Philpott. Des Moines, Iowa, State Leader Co. 1881. Pp. 21.

Ethylene Bichloride as an Anæsthetic Agent, pp. 12; and Convulsions due to Depression of Spinal Reflex-Inhibitory Centers, pp. 5. By Edward T. Reichert, M. D. Reprints from the Philadelphia "Medical Times," 1881.

Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Indiana. By Professor Charles R. Barnes. Crawfordsville, Indiana. 1881. Pp. 38.

"Journal of the American Chemical Society," Vol. III, Nos. 1-6, January to June, 1881. New York: The American Chemical Society.

Bacteria. By Dr. Ferdinand Cohn. Translated by Charles S. Dolley. Rochester, New York. 1881. Pp. 30.

Remarkable Change in the Color of the Hair in a Patient under Treatment by Pilocarpin, etc.; and Case of Membranous Croup treated Successfully by Pilocarpin. By D. W. Prentiss, M. D. Philadelphia: J. B. Lippincott & Co. 1881. Pp. 15.

A Dictionary of Music and Musicians, A. D. 1450-1881. Edited by George Grove, D. C. L. London and New York: Macmillan & Co. 1881. Part XIV. Richter to Schoperlechner. Price per part, $1.

Subjects and Questions pertaining to Political Economy, Constitutional Law, Current Politics, etc. New York: The Society for Political Education. 1881. Pp. 24. 10 cents.

A Short History of the Bible. By Bronson C. Keeler. Chicago: The Century Publishing Co. 1881. Pp. 196.

Elements of Geometry. By Simon Newcomb. Pp. 399. $1.75. English History for Students. By Samuel R. Gardiner, LL. D. Pp. 424. $2.25. The Wandering Jew. By Moncure D. Conway. Pp. 200. $1.50. New York: Henry Holt & Co. 1881.

Report of the Commissioner of Education for 1879. Washington: Government Printing-Office. 1881. Pp. 757.

Manual of Sugar Analysis. By J. H. Tucker, Ph. D. New York: D. Van Nostrand. 1881. Pp. 353. $3.50.

The Harrogate Waters. By George Oliver, M. D. London, Eng.: H. K. Lewis. 1881. $1.50.

The Land of the White Elephant. By Frank Vincent, Jr. New York: Harper & Brothers. 1881. $3.50.

An Artistic Treatise on the Human Figure. By Henry Warren, K. L. Edited by Susan N. Carter. Pp. 82. 50 cents. Animal Physiology for Schools. By J. Milner Fothergill. Pp. 112. 75 cents. The Autobiography of Mark Rutherford. Edited by Reuben Sharpcott. Pp. 218. $1. Bacon. By Thomas Fowler, M. A., etc. Pp. 200. $1.25. New York: G. P. Putnam's Sons. 1881.

Principles of Chemical Philosophy. By Josiah Parsons Cooke. Boston: John Allen. 1881. Pp. 623. $2.50.

The Publishers' Trade List Annual for 1881. New York: F. Leypoldt, September, 1881. $1.50.

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# POPULAR MISCELLANY.

**Gesture-Speech.**—Colonel Garrick Mallory, of the United States Army, delivered a lecture on "The Gesture-Speech of Man," at the last meeting of the American Association, in which he remarked that North America had showed more favorable conditions for the development of gesture-signs than any other thoroughly explored part of the civilized world. Its aboriginal population was scanty, and so dialectically subdivided, with sixty-five families of languages, some comprising twenty languages each, that few bands could readily converse with each other. The Alaskan tribes generally used signs not more than a generation ago. The use of gestures could not be accounted for by any theory of the poverty of Indian languages, for no such theories were true, neither was it correct to suppose that a gesture-language was originated by a certain tribe, or in a particular region, and thence spread. The sign-language among the Indians is not uniform, and it is no argument in favor of uniformity that the signs used by any of the tribes are generally understood by others, for signs might be understood without being identical with any before seen. Regarding the question, whether the signs were conventional or instructive, Colonel Mallory was of the opinion that sign-language, as a product of evolution, had been developed rather than invented, and yet it seemed probable that each of the separate signs had a definite origin arising out of some appropriate occasion, and the same sign might in this manner have had many independent origins, due to indentity in the circumstances, or, if lost, might have been reproduced. The studies so far pursued led to the conclusion that at the time of the discovery of North America all its inhabitants practiced sign-language, though with different degrees of expertness. The language has been disused with some, but with oth-

ers, particularly with those which have become nomadic, it has been cultivated to a high degree of development. The signs have their birth, growth, development, changes, and death, and those which are in general use must be of great antiquity. Colonel Mallory's researches during several years showed a surprising number of signs for the same ideas which were substantially identical, not only among savage tribes, but among all peoples that used gesture-signs with any freedom. Indians who have been brought to the Eastern States have often had happy intercourse by signs with white deaf-mutes; many of their signs were identical, and all sooner or later were mutually understood. The so-called sign-language of the Indians is not, properly speaking, one language, but it and the gesture systems of deaf-mutes and all people together constitute one language—the gesture-speech of mankind—of which each system is a dialect. Colonel Mallory next showed how this language of gestures aided archæological research. The Indian signs, as well as their myths and customs, form a part of the paleontology of humanity, to be studied in the history of the latter, as the geologist, with similar object, studies all the strata of the physical world.

**The Origin of Lake Erie.**—In a paper, read at the recent Cincinnati meeting, on the evidence from the drift of Ohio in regard to the origin of Lake Erie, Professor E. W. Claypole endeavored to show that the theory that the lake-bed was excavated by local glaciers at the oncoming and passing away of the ice age was not competent to account for the depth of the basin. A careful examination of the drift of Ohio in various parts of the State had convinced the author that the average depth of the erosion performed by the great continental glacier did not exceed fifty-six feet. If this was the limit of the effect produced by this immense mass of ice during its whole duration, it was idle to ascribe to a small local glacier the removal of many hundred feet deep of rock which was involved in the excavation of the bed of Lake Erie. Moreover, if the lake-basin had been so formed, the material taken out would have been found piled up like a mountain around the southwest end of the lake, but it is not so found, and the drift in that region is not perceptibly deeper than in other places. Furthermore, no local glaciers could have been formed unless the lake-beds had previously existed in their present form and size, and to ascribe the beds to the action of such a glacier is to mistake cause for effect. Observations of the drift in Indiana and Illinois go to confirm this view. The glacial theory being held to be untenable, the only alternative is to ascribe the formation of the lake-bed to the action of an ancient pre-glacial river, to which Lakes Erie and Ontario would be a broad, open valley, worn out where the rocks were soft, and connected by deep channels where they were hard, and this river he proposed to call the Ontario River. Mr. Holley replied to Professor Claypole's arguments, by exhibiting sections of the lakes and their rivers, and pointing to the fact in respect to the Niagara River, unique among American rivers, that while the descent of the river is in one direction the rise of its banks is in an opposite direction; the elevation anciently formed a dam which set the waters back to Lake Michigan, causing the constitution of an immense inland lake, which emptied its waters through the Illinois and Mississippi Rivers. In this theory, Professor Claypole might find a way to get rid of his drift.

**Ancient and Modern Shells.**—Professor E. S. Morse presented at the last meeting of the American Association some observations on changes of form which shells of the genera *Mya* and *Lunatia* seem to have undergone since the New England shell-heaps were deposited. This had been ascertained by comparing the shells of the ancient deposits and living shells of the same species, in New England and Japan, where similar changes were found to have taken place. It appeared, from measurements that he had made of the common clam (*Mya*), at Goose Island, Maine, and at Ipswich and Marblehead, Massachusetts, that the ancient specimens were higher in proportion to their length than the recent specimens. A comparison of the common beach-cockle (*Lunatia*) from the shell-heaps of Marblehead, Massachusetts, showed that the present form living on the shore to-day had a more de-

pressed spine than the ancient form. In another paper, Professor Morse, after referring to the fact that, although worked shells were not uncommon in the shell-heaps of Florida and California, none had been found in the New England and Japanese shell-heaps, exhibited specimens of the large beach-cockle (*Lunatia*) from Marblehead, Massachusetts, which had unmistakably been worked by cutting out a part of the outer whorl near the suture. To show that this could not have been artificially broken, he exhibited naturally broken shells of the same species, both ancient and recent, in which the fractures were essentially unlike those of the worked shells.

**Who were the Mound-Builders?**—Dr. W. De Haas, after a careful examination of the supposed connection between the "mound-builders" and the ancient races of Mexico, has come to the conclusion that it does not exist. He considers that the former people were but little advanced beyond the modern Indians, but that they were different. In the discussion that followed the reading of Dr. De Haas's paper in the American Association, Judge Henderson objected to the use of the term "mound-builder," as one that conveyed a false idea. There is no evidence, he said, which will justify us in separating the ancient and more modern races, not a single feature peculiar to the so-called mound-builders. The speaker had started out in the study of American archæology with the impression that these people were distinct and separate from the Indians, but he had been compelled by the force of facts to relinquish the theory. It was improper to talk about these people as mysterious, for they were no more mysterious than the Shawnees, the Natchez, the Tensas, and other tribes. The cloth found in their works was like that made by every tribe from the Lakes to the Gulf, even less fine than some, and their pottery was no better. In short, the speaker said, in his judgment, the mound-builders were the ancestors of the Indians.

**M. Trouvé's Electric Canoe.**—"La Nature" gives the details of a series of experiments made upon the Seine, at Paris, in the latter days of May, with the electric canoe and motor invented by M. G. Trouvé. The motor is composed of an improved Siemens coil, which acts through a Vaucasson chain and a Galle chain upon a three-bladed screw fitted into an opening cut out of the rudder to receive it. It is fixed to the upper part of the rudder, so that it, as well as the screw, follows all its movements. The motor employed in the experiments was composed of two coils, and, with its accessories, did not weigh more than five kilogrammes (twelve and a half pounds). It was placed in the stern of a canoe, the Telephone, which measured seventeen feet ten inches by three feet ten inches, and weighed one hundred and eighty pounds. Two cup batteries of bichromate of potassa, composed of six elements each, and weighing together sixty pounds, were placed in the middle of the canoe. They were connected with the motors by two cords, which served at the same time as envelopes for the conducting wires and as tiller-ropes, and which were furnished with appurtenances for applying or shutting off the current at will. The motor is independent, and can be applied to any boat. The first experiments were made on the 26th of May, when the boat was worked for about forty-five minutes by M. Trouvé and M. Tissandier, in the afternoon, and by M. Trouvé and others for about the same time in the evening. A third experiment was made on the 31st of May, in the presence of M. G. Berger, commissioner-general of the Universal Electrical Exposition, M. A. Breguet, of the "Revue Scientifique," M. Hospitalier, M. Fricéro, of the Russian navy, and others. The Telephone, with three persons in it, easily went up the Seine six times for a distance of two hundred metres, or six hundred and fifty feet, at the rate of one metre in a second, and descended at the rate of two and a half metres in a second. Other experiments were made on the 2d of June, in presence of the Russian Admiral Likhatchof and a number of spectators interested in science or navigation. These experiments recall a similar attempt made on the Neva in 1839, by Jacobi. He used on the occasion two Grove batteries, each composed of sixty-four couples of zinc and platinum, and presenting a surface of sixteen square feet. The

boat, propelled by paddle-wheels, and carrying twelve persons, sailed upon the river for several hours against the current, and in spite of a violent wind; but the operators were greatly inconvenienced by the nitrous gas, which escaped in great quantities, and the spectators on the banks were obliged, by the suffocating fumes, to leave the place. Electric navigation may be considered to have originated with this experiment.

**The Kafirs of Kafiristan.**—The Kafirs, who inhabit the country called Kafiristan, which lies south and southeast of the Hindoo-Koosh Mountains, are so called by their Mohammedan neighbors after a term signifying unbeliever, because they are not of the Mohammedan faith. They are an Aryan people of unknown origin and history, divided into a number of tribes speaking as many tongues; they are ethnically distinct from any of their neighbors; their religion is pagan, but neither Hindoo nor Buddhist, and they are in constant hostility with the Mohammedans. Possibly they represent the Aryan race in the nearest to the primitive state in which it can now be found. They have never been visited by a European. Colonel H. C. Tanner, who has furnished an account of them to the Royal Geographical Society, has been nearer to them than any other Englishman, having been invited by influential Kafirs to visit the country as their guest, but he was prevented by sickness from getting any farther than the country of the Chugáni, a Kafir tribe who have embraced Mohammedanism, living on the borders of Kafiristan. The Chugáni live in the highest habitable parts of the Kund range. They are of the Suni faith, and are the only Mohammedans in the region who allow their women European freedom. One of the principal towns is Aret, a village of six hundred houses, which are built on the face of a very steep slope, and arranged in terraces one above the other. The view from below presents a vast amphitheatre of carvings, with which the wood-work of the houses is covered. Inside, the furniture consists of cots (*kát*), stools (*stá*), and earthen vessels with Grecian-looking ears, cheese-making utensils, and agricultural implements—wooden shovels, rakes, etc.—stuck between the blackened rafters; and the impression on the whole is one of superiority to most Indian habitations. The burial-places are scattered among the rocks in any spots not too steep for them, and the graves are built with stones and covered with slabs, so that the bodies shall not come in contact with the earth. Highly ornamented and fantastically carved posts stand at the head and foot of the graves. The posts of a new grave were painted red and adorned with pegs, representing the number of enemies the deceased had killed during his lifetime. The Sanu Kafirs are a merry people, fond of dancing, music, and wine, who shake hands in the English fashion. Their religion is simple. Men call on the gods for aid in battle, and pay offerings to them if successful in the fight, storing the offerings in the temples, some of which contain the accumulations of hundreds of years. They do not bury their dead, but place them in wooden coffins and stow them away in caves in the mountains. The country probably contains interesting antiquities, for stones are told of with ancient writing engraved upon them; ruins exist at Islámabad and at Bimbakot, the reputed capital of the Hindoo Bim Raja; and the petrified remains of Noah's Ark are said to rest on the shores of a lake on the summit of Kund, while the legendary tomb of Lamech, Noah's father, is in the plain below, and the name of Noah seems to be very common. Colonel Tanner found an exact representation of a Kafir knife in one of the *topes*, and dug up a number of small, well-executed pictures from the life of Buddha, in limestone, at the same place.

**The Coal Production of the World.**—Professor von Neumann, of Vienna, estimates, in his "Review of the Production, Traffic, and Commerce of the World's Economy," that the annual product of coal in the whole world increased from 136,000,000 tons in 1860 to 294,000,000 tons in 1877. Great Britain was the leading producer, during the whole period, and returned an output of 137,000,000 tons in 1878. The United States, which stands next, returned 55,200,000 tons in 1877. Germany, France, Belgium, and Austro-Hungary follow in

their order. The drain upon the earth's stock of coal has hardly begun yet. The known fields of China, still almost unbroken, are supposed to have an area of 200,000 square miles; those of the United States of 193,870; the East Indian fields of 35,000; the British fields of 9,000; Germany, France, and Belgium have small fields; one field in Russia covers 13,600 square miles; Japan has coal-fields in fifteen of its thirty-eight provinces; Australia has excellent coal to supply the lands of the Pacific. Great Britain consumes coal at the rate of 3·6, the United States of 1·06, Germany of 1·1, France of 0·64, Belgium of 1·96, Austro-Hungary of 0·33 ton per inhabitant. In England about one third of the coal is used in the manufacture of iron and steel, more than one fifth in the large industries, more than one sixth for domestic purposes, and the rest is consumed by gas-works, water-works, mines, railways, and steamers. In France, the metallurgical, industrial, and gas works consume 72 per cent., the household 13 per cent., the transporting industries 10 per cent., and the mines 4 per cent. of the whole amount. The coal-mines of the world employ about 1,100,000 men, viz., 514,500 men in England, 210,000 in Germany, 97,000 in France, 101,000 in Belgium, more than 100,000 in the United States, and 63,000 in Austro-Hungary.

**Intellectual Condition of the Savage Negro.**—M. de Rouvre gives, in the "Bulletin de la Société de Géographie," a darkly-colored view of the mental and moral capacity of the negroes of southern Guinea. The black, he says, has no initiative, and is completely destitute of metaphysical conception and abstract ideas. The seat of the intellectual functions appears to be paralyzed or atrophied; the comprehension is inert. He receives no impression of the beautiful, of the grand; feels no love, no other passion than the bestial instinct; knows no distinction between good and evil, except that which is imposed by the fear of punishment. Therefore, he experiences no satisfaction over a good deed, no remorse over a wicked one. His enjoyments lie in eating, drinking, and sleeping. He has no conception of property beyond that of an infant that prizes what it has without thinking of its real value, and has no scruples against taking what is another's if the notion strikes it. The black, from sheer unintelligence, is unmoved by the sight of our machines. The crew of M. de Rouvre's pirogue, when he visited the frigate Bellona, were taken through the ship and shown it by a quartermaster, but paid more attention to the biscuit and rum that were offered them than to any feature of the vessel or its equipment. M. de Rouvre showed some of them a photograph of a friend who had a long beard and with whom they were well acquainted; they remarked, after looking at it in every aspect, "You have a very pretty wife in Europe." As a rule, when anything is shown them, they look at the person who points it out rather than at the object, try to divine what he thinks about it, and repeat that. It is impossible to convince them that anything can be different from what it is; but they regard everything with a mixture of superstition, incapacity, and perversity. They have never thought of digging wells in their towns in time of drought, though they suffer greatly from the want of water, and have often seen how the Europeans provide it in their factories. Some of them have visited Europe, without having received any permanent improvement. One young man went to Paris and learned to speak French and dress in the European style, but resumed his natural life as soon as he returned home, reserving only a kind of varnish to cover the duplicity with which an incomplete education had endowed him. All the traces that were left of his education were an increased power of discovering what was really wicked, and of putting what he had learned to the service of his unrestrained instincts.

**Action of the Different Rays of the Spectrum.** — Assuming that the rays of the spectrum vary simply by their wave-length, or quantitatively, M. Lermantoff, of St. Petersburg, believes it probable that their mode of action on bodies is really the same. The dark heat-rays produce a sensible heating of the entire body; but each superficial molecule that receives directly the energy of the ray is heated much more than the rest of the body, and communi-

cates its excess of heat by conductivity. The luminous and ultra-violet rays produce a similar effect; but the motion which they communicate to the molecules is distinguished by greater velocity, corresponding to a higher temperature. Such an hypothesis of molecular heating is sufficient to explain most of the effects produced by light on bodies. The incandescence of the superficial molecules, under the influence of the most refrangible rays emanating from a source at high temperature, must persist for a finite time after the cessation of the action of light. In this, perhaps, lies the direct explanation of the phosphorescence of short duration which M. Ed. Becquerel has observed in nearly all solid bodies. Fluorescence is also explained by the same hypothesis, if we regard it as a phosphorescence of short duration sufficiently intense to be seen during the action of the light. In general, moderate elevation of temperature favors the reactions of combination, while in the highest temperatures all known combinations undergo dissociation or decomposition. Thus, according to M. Lermantoff's hypothesis, the less refrangible parts of the spectrum should produce principally reactions of combination, and the more refrangible parts decompositions. This is precisely what M. Chastaing has proved for the particular case of oxidations.

**Metallic Anti-Resonators.**—It is known that resonances in public halls can be modified or prevented by stretching wires across the ceilings; and the principle has been rudely applied in a number of instances with fairly satisfactory results. Mr. A. C. Engler, of London, has invented a plan for a systematic arrangement of steel plates, or wires, which promises to accomplish the object more completely. The effect of the plates is to take up the most gentle vibrations and greatly to increase the speed of transmission. Wires have a similar property, and are more convenient. In the most advantageous application of Mr. Engler's invention, one or more layers of steel wires are stretched along the length of the room, a few feet below the ceiling, connected by cross-wires and spiral springs, and properly tuned, so that the vibration may be absorbed and conveyed from one wire to another, and instantaneously spread over the whole building; and the words of the speaker or the notes of the singer are so accelerated that they reach the audience about fifteen times more quickly than under ordinary arrangements. The effect is improved and the tone enriched by using steel plates. The system has been applied—imperfectly, for the wires had to stop short of the wall at one end—in a lecture-room at the South Kensington Museum of notoriously bad acoustic properties. Twenty-eight lengths of steel wire were stretched across a distance of sixty feet, and connected at the end by steel-wire springs. Above them were three other steel wires, connected with the lower group, so as to form a perfect network of wires. The effect was a complete distribution of the sound, so that a speaker at the lecturer's table could be heard distinctly in any part of the theatre, and all the acoustic defects of the hall were considerably mitigated.

**Decline of Country Population in England.**—The returns of the new English census show that the growth of the towns at the expense of the rural villages and the agricultural districts, which has been remarked in previous censuses, still continues; and it is not certain that the process of depletion of the country is not progressive. The younger people are leaving their rural homes so rapidly that in some parts of the kingdom the difference is sufficient to strike even casual travelers. The causes of the decline of the agricultural population are supposed to be attributable partly to the increasing use of machinery, which reduces the demand for hands; partly to reduction of wages; but chiefly to an increase in the dislike for agricultural labor under existing conditions. The towns offer better pay, more steady employment, better protection from the weather, and more hope of reaching an improved condition, than the farms; and work in towns, if it is hard, is more lively and gregarious than agricultural labor. The remedy suggested for the evil, if one is to be applied, is peasant proprietorship, under which the man who works may, as on the Continent and in the United States, feel that he is laboring for himself.

**The English Mile.** — M. Faye has explained why it takes sixty-nine and a half English miles to make a degree instead of sixty, as was probably intended when the mile was established. The English geographers deduced their mile from Ptolemy, and Ptolemy refers to Eratosthenes. Eratosthenes measured the arc of the meridian on the basis of the distance between Syene and Alexandria, in Egypt, which gave seven hundred stadia to the degree. Ptolemy says that he verified the measurements of Eratosthenes, and found the same result, which he gives, however, as five hundred stadia to the degree. The discrepancy arises from a change which took place in the standard of the foot—of which six hundred went to the stadium — during the four hundred years between Eratosthenes and Ptolemy. Eratosthenes used the ancient Egyptian foot, which is shorter than ours, while Ptolemy used the Phileterian foot, which is longer than ours. Making allowance for this difference, the two measurements agree. The English geographers, in making their calculation, believed that Ptolemy had used still another foot, the Greek foot, which is one and a half hundredths longer than ours, but shorter than the one he did actually use. If the English geographers of the sixteenth century had strained this valuation ever so little, and had carried it to five one-hundredths, they would have found 630 English feet for the stadium, which they believed to be 600 Greek feet, and these 630 feet, or 210 yards, multiplied by 500, would give them 105,000 yards for the degree, and exactly 1,760 yards for the mile.

**The International Electrical Exhibition.**—The International Exhibition of Electricity at Paris was satisfactorily opened August 11th, though the preparations still lacked something of being completed. The exhibition represents, in two distinct divisions—first, appliances of electric lighting; and, second, the other applications of electricity. In the second division, England and Germany have the first places on the left of the entrance, with one thousand square metres of space each; after them follow, in order of the size of their exhibits, Belgium, America, Austro-Hungary, Russia, Sweden and Norway, Italy, Spain, Switzerland, Holland, and Denmark. Japan exhibits a table of porcelain vases and jars of lacquered stuff for insulators. The French exhibits are on the right, and in the center of the palace is an electric lighthouse, surrounded by a basin, in which a boat propelled by electricity moves around. The twenty-eight rooms of the first floor are each lighted by a different system of electric lighting. One room, lighted by the sunlamp, contains pictures and works of art to show the application of electricity to the lighting of museums. Another room is a completely furnished theatre, lighted by the Werdemann system. Two other rooms, furnished as a suite, contain the applications of electricity to domestic and social life. In the next rooms electrical playthings are collected, and in the rooms adjoining are telephones, by means of which visitors are brought within hearing of the Opéra and the Théâtre Français. Other rooms are devoted to electropathy, electric photography, testing instruments, a retrospective exhibition of historical apparatus, and, lastly, Mr. Edison's inventions. Visitors are brought from the Place de la Concorde to the door of the exhibition on an electric tramway, and a little electric railway for the transmission of letters and telegrams traverses the south gallery.

**Propagating Sponges by Cuttings.**—The Austrian Government has made some successful experiments in the propagation of sponges from cuttings in the Adriatic Sea, accounts of which have been published by Dr. Emil von Marenzeller, in the "Transactions of the Zoölogical-Botanical Society of Vienna." The most suitable season for undertaking the propagation is the winter; for, although the growth of the sponges and the healing of the cut surfaces takes place more slowly then than in the summer, the sponges are much less liable to be spoiled by putrefaction. The suitableness of a spot for the cultivation is surely indicated by the freshness and liveliness of the marine algæ growing in it. It demands a bay sheltered from strong waves and currents, but not quite still, a rocky bottom, clothed with living algæ, and a moderate ebb and flow of the tide. In all cases the neighborhood of the mouths of brooks, rivers, and sub-

terranean springs, must be avoided. The worst enemy of sponge-culture is mud. The sponges chosen for cutting must be gathered by experienced hands, with all possible gentleness, so as to avoid tearing them. They should be cut up rapidly, with a common knife, or, better, a saw-like blade, being laid for the purpose on a smooth wooden board, moistened with sea-water, into pieces of about one cubic inch each; and it is well that each cutting should have the greatest possible area of uninjured outer skin. A healthy piece of sponge firmly attaches itself to any surface with which it comes into intimate contact, in a short time. Preference is given to stone as a foundation, because it is the natural ground and is not attacked by the teredo, which seems to be a dangerous enemy to the culture. The Austrian culturists generally attached their cuttings by pegs to a kind of wooden apparatus, taking care to avoid lacerating the sponge, and forcing and squeezing, which cause a loss of sarcode, and metals, which cause rot, and sink it into the water. Too much light and too little light must be avoided; the sponges must be kept constantly moist with sea-water during the preparation, especially in warm weather; and all wood-work must be tarred, to delay (for it does not prevent) the ravages of the pile-worm. If the cuttings hold fast after three or four weeks, the propagation is regarded as secure. A characteristic feature is the tendency of the cuttings to assume a round form, and the apparatus for planting them is shaped to promote this. The period of growth varies considerably, but generally a term of seven years is required to produce a marketable and profitable article. The question whether this mode of cultivation is profitable appears to have two sides. Dr. Marenzeller considers it doubtful whether it is advantageous to cut in pieces a sponge which, uncut, would have more quickly reached the same size and height as the collective cuttings, and thinks that attention may be better directed to the development of ill-shaped ones into good-shaped ones.

**Experiments in Vision.**—MM. Macé and Nicati have found that persons with normal vision, when looking at the solar spectrum, form considerably different estimates of the distribution of light in it. They have since experimented with four Daltonians, or color-blind persons, and observed that in three of them the vision of red was very feeble, that of yellow was normal, and that of green appeared to be even sharper than in normal-eyed persons, while in the fourth the conditions were reversed. Between Daltonians who could not perceive red, differences were noticed in the powers of vision of blue and violet, similar to those met in normal eyes. M. Charpentier has experimented by looking in darkness at an opaque screen perforated by a number of minute holes, which were distinguishable in a moderate light, and learned that a very faint light merely produces a diffuse luminous sensation; a greater quantity of light gives the notion of color, if color is present; and a still greater quantity is required to produce the perception of form.

**The Interstellar Ether.**—Professor T. Sterry Hunt, at the recent meeting of the American Association, explained his peculiar views of the nature of the interstellar ether. Having referred to the theories of different philosophers respecting the extent of the earth's atmosphere and the nature of the ethereal fluid, he said that processes have been going on from the earliest ages which have absorbed and evolved enormous quantities of gases. For instance, in the manufacture of the limestone rocks of the earth alone over two hundred times the amount of the carbonic dioxide now in our atmosphere have been consumed. This must have been borrowed from space. Professor Hunt then discussed the probability of a chemically compound ether, exceedingly attenuated, existing in the interstellar space, and pervading the universe just as the atmosphere surrounds the earth.

**Vaccination for the Anthrax.**—After a long series of experiments M. Pasteur has found a method of attenuating the virus of the carbuncle, or *anthrax*, of cattle and sheep, and of vaccinating animals with it so as to give them an effective protection against the disease. The sufficiency of the remedy was attested by inoculating with the active virus sixteen sheep, taken as they came from the flock, and nineteen

sheep which had been previously vaccinated. Three days afterward fifteen of the sixteen unvaccinated sheep were dead, while the nineteen vaccinated ones were perfectly healthy. M. Toussaint has discovered that a female animal which has been inoculated for this disease transmits her immunity to her offspring, and that equally well whether the inoculation was made before conception or afterward.

## NOTES.

Professor T. J. Burrill, in the "American Naturalist," refers certain blights and diseases of plants to the agency of bacteria. Those organisms appear to be an active cause of the blight in pear and apple trees. The cells of blighted pear-trees are destitute of the starch-grains with which the healthy cells are filled, but traces of fermentation have been discovered in them, and bacteria have been uniformly observed in the juices of diseased pear and apple trees. The death of patches of bark on the trunk and larger limbs of apple-trees is ascribed by Professor Burrill to the same cause. The yellows of the peach-tree have been shown by the discovery of bacteria under the microscope to be caused by a similar organism, as are also the blights of the Lombardy poplar and the aspen.

Mr. E. E. Fish, in the "Bulletin" of the Buffalo Society of Natural Sciences collates several instances to show that the power of repeating from imitation other sounds than their own notes, which has been noticed in only a few species, is common to many birds. He has observed the sparrow singing clearly the song of the chewink or towhee bunting and of the pewit; the robin interspersing the notes of a phebe-bird with each song, "with such exactness as to deceive any one who might not see the bird while singing"; another robin utter the notes of the oriole; the red-eyed vireo whistle the "Bob White" of the quail, deceiving those who heard it and did not see it.

How fallible is a name as a guide to any fact in respect to the article to which it is applied is curiously shown in the case of the "Jordan almonds," which even Philip Miller, in Bailey's Dictionary, said were so called because the best of them grew near the river Jordan. In fact, no almonds come, or ever did come, from the Jordan. An old work, however, mentions "Jardyne almaunde, *Amigdalum jardinum*," and solves the doubt. Jordan is a corruption of jarden; the Jordan almond is simply a garden or cultivated almond.

Mr. James B. Francis, President of the American Society of Civil Engineers, endeavoring to account for the origin of anchor or ground-ice, shows that it is formed in streams where the water is much disturbed, rising and falling in upward and downward currents. The ice-needles in course of formation, having nearly the same specific gravity, are carried down with the descending currents, and many of them become attached to the bottom by regelation. Of the immense number of needles that are formed, enough thus adhere together at the bottom to form a mass of ice there. The essential conditions to the formation of ground-ice are, that the temperature of the water must be at the freezing-point, and that of the air below it; that the surface of the water must be exposed to the air, and there must be a current in the water—all of which are in harmony with this theory. The adherence of the ice to the bottom is always down-stream from where the needles are found, and in large streams it is many miles below.

Professor Alexander Hogg, in an address, at Marshall University, Texas, illustrated the extent to which the English language has spread, by referring to the time when Mary Beatrice, of Modena, about to marry the Duke of York, afterward King James II, did not know where England was; then to one hundred years ago, when French was spoken by twice as many native Frenchmen as there were English-speaking people, while German was the language of at least an equal number, and Spanish had a wider geographical range than either German, French, or English; and, comparing these periods with the present, when English is the language of one hundred million people, and bids fair, before another hundred years, to be that of ten times as many.

Mr. Rhees's biography of Smithson, published by the Smithsonian Institution, states that the precise date and place of his nativity are unknown. Mr. Joseph L. Chester states, in the "Academy," that the matriculation register of the University of Oxford shows that Smithson matriculated as James Lewis Macie, from Pembroke College, on May 7, 1782, at the age of seventeen, and that he was a native of London. As the age at the last birthday was always required, it follows that he was born between May 7, 1764 and May 7, 1765. The date, about 1754, given by Mr. Rhees as that of Smithson's birth, is, then, ten years too early.

M. Schlumberger, describing the powerful antiseptic qualities of salicylic acid, says that, employed in infinitely small doses, it hinders the action of nitrogenous ferments, and forms stable combinations with them. In hygiene, it is a valuable disinfecting and

sanitary agent. The French railway companies have for some time used it as a wash to cleanse their cattle-cars. In some countries it is employed as a remedy for certain affections of animals, and as a prophylactic against contagious diseases. These services, important as they are, are surpassed by those which this substance is made to render in the preservation of food. The quantities of the acid which are required for this purpose are very minute, and no case of injury to any person has been traced to it during the six years in which it has been in increasing use; yet some physicians have expressed the apprehension lest the continuous daily consumption of salicylized food may eventually produce derangement in the system. The subject deserves careful examination.

M. G. HAYEM, having studied the physiological and medical effects of inhalations of oxygen, reports that when taken regularly, mingled with an indeterminate quantity of common air, oxygen produces an energetic stimulation of the nutritive faculties. It is especially beneficial to chlorotic patients, in whom it restores the appetite, stops vomiting, revives the movement of assimilation, and causes increase of weight. Inhalations of oxygen form a useful auxiliary in the treatment of chlorosis with iron, especially when gastric troubles make the application of this treatment more difficult. The inhalations are especially characterized by the control they exercise over vomiting, which is often suspended after one or two applications. They have also been observed to promote an increased elimination of urea.

MR. G. S. JOHNSON has effected the synthesis of ammonia by passing a mixture of hydrogen and pure nitrogen over spongy platinum at a low red heat, when ammonia was produced at the rate of 5·9 milligrammes per hour. The experiment was varied in different ways, under one of which ammonia was produced at the rate of twenty-four, under another of three, milligrammes per hour, while in others none was produced. From all the experiments, Mr. Johnson has concluded that nitrogen, like phosphorus, may exist in two states, active and inactive, the latter being brought on by exposure to heat.

CATHERINE C. HOPLEY suggests in "Land and Water" a new theory of the so-called fascination of birds by snakes. It is that the bird mistakes the snake's tongue, which the animal keeps in constant motion, while it otherwise remains perfectly still, for a lively worm, and gazes at it with the expectation of making food of it. The idea was suggested by observations at the Zoölogical Gardens, where the birds were frequently seen watching the tongues of the snakes.

ATTEMPTS have been made in England, applying the principle of the Bessemer process, to facilitate the extraction of copper from the sulphuret by blowing air into the pyrites, in order to consume the sulphur and make it at the same time a source of heat for the continuance of the process of reduction. They have failed, because the bath would lose its heat as soon as the sulphur was consumed. The discovery has been made in a factory at Lyons, France, that the presence of a compound containing phosphorus will protract the continuance of the required temperature till the process is completed. The order of the combustion appears to be, first of the sulphur, next of the metallic impurities, lastly of the phosphorus.

THE French Minister of Public Instruction has appointed a commission on hygiene of the eyes in schools, for the purpose of investigating the influence of the material conditions of the arrangement and furnishings of the school-room—the seats, desks, position of the light, etc., on the progress of myopia, and of looking for means of opposing them. Dr. Gavarret is president of the committee, and Dr. Javal is one of the members; and, in order that questions of typography may not be overlooked, it includes two publishers and a printer.

M. E. BOUCHUT has suggested the use of the digestive juice, papaine, which we have recently described, for the dissolution and digestion of the false membranes of diphtheria. He has, in his experiments, seen a thick, resisting, and elastic false membrane from the trachea which he had placed in a tube with one third part of the juice of the papaya, dissolved in a few hours when cold, and in a few minutes when the tube was warmed. Since beginning his studies on this subject he has treated thirty-two cases of infants or adults, two of which were very severe, and lost only four.

M. GLEY, a French physiologist, has, from experiments made upon himself respecting the effect of attention and intellectual work upon cerebral circulation, confirmed the results of M. Mosso and added some new observations. He finds that the rhythm of the heart suffers an acceleration which is increased in a direct proportion with the intensity of the attention. Thus the pulse was quicker when he studied geometry than when he studied philosophy, with which he was more at home. The carotid artery is also dilated during cerebral work, and the carotidian pulse becomes dicrotic, but the radial pulse becomes smaller and less ample. The phenomena of congestion observed in the brain persist for a certain time after cerebral activity.

PAUL BROCA.